2015-12

Technological evolution of high temperature superconductors

White, Jordan R.

Monterey, California: Naval Postgraduate School

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

TECHNOLOGICAL EVOLUTION OF HIGH TEMPERATURE SUPERCONDUCTORS

by

Jordan R. White

December 2015

Thesis Advisor:	Clifford Whitcomb
Co-Advisor:	Fotis Papoulias

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704–0188*

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.

1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** December 2015	**3. REPORT TYPE AND DATES COVERED** Master's thesis

4. TITLE AND SUBTITLE TECHNOLOGICAL EVOLUTION OF HIGH TEMPERATURE SUPERCONDUCTORS	**5. FUNDING NUMBERS**
6. AUTHOR(S) Jordan R. White	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol number ____N/A____.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited	**12b. DISTRIBUTION CODE**

13. ABSTRACT (maximum 200 words)

High temperature superconducting (HTS) cables are currently being used in the commercial energy industry primarily for demonstration purposes and to evaluate the feasibility of large-scale implementation into the electric grid. While still in the evaluation stage, the U.S. Navy is finding the test results promising and is investigating its potential use for future electric ships to supply power to electric propulsion motors and possible high-energy weapons such as rail guns and lasers. Moreover, the Navy successfully tested an HTS degaussing system on a modern U.S. destroyer in 2008. The day of full-scale HTS integration is quickly approaching. This thesis used the IHS Goldfire Cloud Connect software in an attempt to determine any current trends of HTS cable innovation and development based on published patents trends. Specific search criteria and filters were used to determine the applicable technology, and those patents categorized by year, were used to develop a regression model to predict future patent trends.

14. SUBJECT TERMS electric ships, high temperature superconductor, HTS	**15. NUMBER OF PAGES** 111
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540–01-280-5500 Standard Form 298 (Rev. 2–89)
Prescribed by ANSI Std. 239–18

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TECHNOLOGICAL EVOLUTION OF HIGH TEMPERATURE SUPERCONDUCTORS

Jordan R. White
Lieutenant, United States Navy
B.S., United States Naval Academy, 2008

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
December 2015

Approved by: Clifford Whitcomb
Thesis Advisor

Fotis Papoulias
Co-Advisor

Ronald Giachetti
Chair, Department of Systems Engineering

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ABSTRACT

High temperature superconducting (HTS) cables are currently being used in the commercial energy industry primarily for demonstration purposes and to evaluate the feasibility of large-scale implementation into the electric grid. While still in the evaluation stage, the U.S. Navy is finding the test results promising and is investigating its potential use for future electric ships to supply power to electric propulsion motors and possible high-energy weapons such as rail guns and lasers. Moreover, the Navy successfully tested an HTS degaussing system on a modern U.S. destroyer in 2008. The day of full-scale HTS integration is quickly approaching. This thesis used the IHS Goldfire Cloud Connect software in an attempt to determine any current trends of HTS cable innovation and development based on published patents trends. Specific search criteria and filters were used to determine the applicable technology, and those patents categorized by year, were used to develop a regression model to predict future patent trends.

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LIST OF ACRONYMS AND ABBREVIATIONS

HTS	High Temperature Superconductor
IHS	Information Handling Services
PDF	Portable Document Format
PITA	Patent: Innovation Trend Analysis
USS	United States Ship
VPN	Virtual Private Network
YBCO	Yttrium-Barium-Calcium-Oxygen

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EXECUTIVE SUMMARY

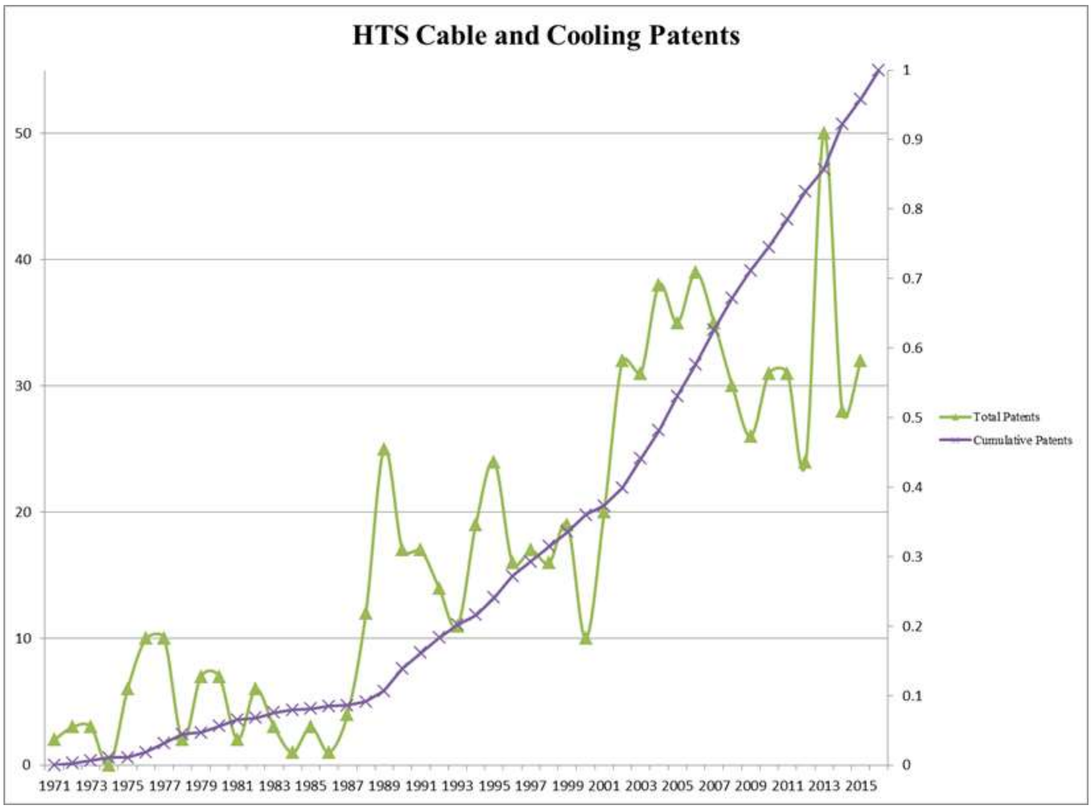
The United States Navy is pursuing the development of an all-electric ship that will utilize electric motors for propulsion and high-energy weapons such as rail guns and lasers. The Navy has a lot of experience with the subject, starting in 1912 with the *USS Jupiter* and its turbo-electric drive system (Navy 2015). Since then, naval warships have become increasingly more dependent on electrical power for weapons, sensors, and propulsion as well, as the *USS Makin Island* became the first hybrid-electric ship that used gas turbine engines and electric motors to drive the ship (Surface Forces Public Affairs 2009). The *USS Zumwalt* furthered these advancements when it was launched with an all-electric drive fed by gas turbine generators (Naval Sea Systems Command 2013).

As the demands for electrical power distribution throughout a ship has increased, the need for efficient transmission of that power has led to the consideration of using high temperature superconducting (HTS) cables to fill that need. HTS cables are special wires that conduct electricity with nearly zero electrical resistance when cooled to an appropriate temperature (Owens and Poole 1996). Modern HTS systems require cooling to temperatures achieved using cheap, widely available liquid nitrogen (Owens and Poole 1996). A major consideration on the use of these cables is the evolutionary trends of the technology to better assess its possible future use.

To identify trends in the technology, a search of patent activity involving the HTS cables and HTS cooling technology was performed using the IHS Goldfire Cloud Connect software. This software provides users with tools to identify corporate and technology trends and perform research through thorough searches of the deep web, corporate knowledge bases, patents, and many other sources.

Using the IHS Goldfire Cloud Connect software, a series of patent searches were performed to identify a relevant list of HTS cable and HTS cooling technology patents. The results were then saved and analyzed to determine any trends. A positive, increasing trend was discovered, which is interpreted to mean that the technology is continuing to develop and improve. A normalized cumulative plot of the patents revealed the same trends. These trends can be seen in Figure 1, showing the patent activity by year from 1970 to 2015 and the cumulative patents on the technology over the same period of time.

Figure 1. HTS Cable and Cooling Patents and Cumulative Patents



Another significant finding was that a large majority of HTS related patents involved manufacturing and production processes for HTS products. This could indicate that industry is preparing for an increase in HTS development.

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ACKNOWLEDGMENTS

I offer my most sincere gratitude and appreciation to my advisors, professors, the staff and faculty for the necessary advice and assistance to help me complete my education at Naval Postgraduate School. I would also like to thank my wife, Megumi, for sacrificing so much of our shore duty time together to allow me to further my academic education.

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I. INTRODUCTION

Over the past several decades, many factors have forced the U.S. Navy into exploring the possibilities and available options for more integrated systems of propulsion, weapon systems and combat systems to increase efficiency and flexibility. This exploration is fueled by innovation, imagination, and the expected needs of the future. What was once conceived as an impossible notion is now a certain destination for the warships of the future. And just as the goal of this research is to determine that destination based on previous and current events, the introduction must start at the beginning of the electric ship.

A. HISTORY OF ELECTRIC SHIPS

1. Electric Propulsion

The beginning of the electric ship arguably began when the first electric lights were installed on *USS Trenton* in 1883 (Naval History and Heritage Command 2014). Even then, the idea was controversial as its reliability and use on ships had never been tested, but the advantages were apparent: it was safer, more efficient, and overall cheaper when compared to the oil and gas lamps that were previously used. In 1912, *USS Jupiter* (AC-3) was launched as the first electrically propelled ship of the U.S. Navy (Navy 2015). Fast forward to 1917 when *USS New Mexico* (BB-40) is launched, the first dreadnought to put to sea with a turbo-electric drive (Naval History and Heritage Command n.d.). This system utilized a steam turbine to turn multiple electric generators, which provided the electric current to drive the permanent magnet motors. This concept was ahead of its time such that the basic principles were sound and relevant even to today, but the technology was immature compared to that of the engines of the day. Turbo-electric driven ships proved to be more inefficient in operation than expected, which resulted in a significantly lower power-to-weight ratio compared to their steam engine counterparts (Babb 2015). As a result of the Washington Treaty, which limited overall-displacements of ships, the turbo-electric drive use became obsolete (Babb 2015). The advantages of the turbo-electric drives were greatly outweighed by the desire to reserve as much weight for armament vice propulsion, thus the steam engine returned to primacy (Babb 2015).

According to Ronald O'Rourke (2000), as weapon systems became more electronics-based, the demand for electrical power on ships increased. Electrical power was being used not only for the lights aboard ships, but also was being used more and more frequently to power larger and greater-ranged RADAR systems, communications systems, and electronic control systems. As these demands increased, the electrical distribution plant was forced to oblige, and thus the electrical equipment went from a supplemental system to a primary provider. The criticality of the generators increased and thus the redundancy and reliability had to increase to accommodate the requirements. O'Rourke states that the U.S. Navy again tested the turbo-electric drive concept during the Cold War in 1953 with AGSS-569 Albacore, a submarine test platform that would eventually result in the *USS Tullibee* (SSN-597) in 1960. He explains that the moderate success of the Tullibee resulted in a follow-on prototype of *USS Glenard P. Lipscomb* (SSN-685). Unfortunately, design complications with *Lipscomb* resulted in unfavorable results and the end of electric propulsion for submarines 1990 (O'Rourke 2000).

The biggest hurdle with the electric drive system during the *Lipscomb* period, O'Rourke points out, was the design of electric motors. It was not until the mid-1980s, he says, that the necessary moderate-horsepower, low-RPM and high-torque electric motors were developed that were necessary to move mid-sized warships at high speeds. Furthermore, the electronic controllers to adequately deliver clean, reliable energy to these motors were developed only in the late 1990s (O'Rourke 2000).

In 2005, the *USNS Lewis and Clark* (T-AKE 1) was launched as the first of class with a new diesel-electric propulsion system that had four diesel generators that served two motors on a single shaft (Friedman 2015). Following this successful endeavor, *USS Makin Island* (LHD 8) was commissioned in 2009 as the first warship to be built with both gas turbine engines and electric propulsion (Surface Forces Public Affairs 2009). During its transit from Pascagoula, Mississippi, to San Diego, California, it was able to save more than $2 million dollars in fuel costs over similar ships and similar transits (Surface Forces Public Affairs 2009).

Construction of what will be the Navy's first "electric-ship," *USS Zumwalt* (DDG-1000) began in 2009, the ship was launched in 2013, delivered to the U.S. Navy in 2014, and expected to be commissioned in 2016 (Naval Sea Systems Command 2013). This ship uses gas turbine generators to provide power to the electric drive motors like previous electric ships, but the main difference being the planned accommodation of high-energy weapons and the reserve ability of the ship's power plant to provide for them (Friedman 2015). All of these high-energy weapons and propulsion systems will need an effective and efficient method of transferring power to them, and high temperature superconducting cables may just be the answer.

2. Electric Weapons

a. Rail Guns

The history of the electric gun is filled with wild stories and high expectations and ultimately crushed hopes and dreams. Theoretical values and assumptions quickly were proven false. According to Ian R. McNab (1999), the story began in roughly 1844 when the first documented claim of an electrically powered projectile firing weapon was known as SIVA, or THE DESTROYER, and was designed and built by a man named Benningfield. The only documentation of this was an advertisement stating that Benningfield was providing a demonstration of the firing of SIVA "at a rate of more than 2,000 per minute, each [cannon]ball having force enough to kill at a greater distance than a mile with certain aim, and continue from year to year at a cost far less than gunpowder, although with more force" (McNab 1999, 250). No other record of the demonstration exists, and as the weapon was never fielded, it can be assumed that the weapon was either a failure or never existed.

McNab continues the storyline, noting the next serious effort was that made by Charles G. Page, a professor of chemistry and pharmacy who, during tests with batteries and magnets, described the concept of an electric gun that used helical coils to electromagnetically fire an iron projectile in 1845. While many of Page's theories were incorrect, his concepts as a whole was largely sound (McNab 1999). Unfortunately, as McNab states, it was not until about 1916 that further documented research into the concept continued, but more successfully, by a Frenchman named Louis Octave Fauchon-Villeplee. Fauchon-Villeplee built a working model that was able to fire a 50 gram, finned-projectile through a block of wood 80-mm thick at a distance of 25 meters. Fauchon-Villeplee envisioned the possibility of mounting such a weapon on the hood of a car and using the engine to power a generator to fire the weapon (McNab 1999). Unfortunately, with the drawdown following World War I the focus on improvements to this design dwindled and was relegated to the research laboratory.

McNab's article explains that development and design of electric weapons continued in Germany, where many leaders saw the use of an electric gun for anti-aircraft guns a perfect fit during World War II. Joachim Hänsler led the scientific efforts and was so confident that the German government issued requirements for a weapon that would launch a 6.5 kilogram projectile to 2,000 meters/second with 72 rounds per minute, but by the end of the war, Hänsler was only able to achieve a maximum of 1,200 meters/second of a 10.3 gram projectile (McNab 1999). The majority of Hänsler's challenges and difficulties were common to those experienced by engineers today: battery capacity and discharge rates, proper materials to use for barrels and projectiles, and overall efficiency of the potential weapon (McNab 1999).

The next major milestone occurred in 2005, when the U.S. Navy's Office of Naval Research (ONR) (2012) initiated the Electromagnetic Railgun Innovative Naval Prototype in 2005. In 2012, ONR successfully fired a prototype railgun with a 32-mega-joule muzzle energy. ONR continues to develop and improve the technology and plans to test the prototype weapon underway in 2016 (McDuffee 2014).

b. Lasers and Electromagnetic Pulse Devices

In the midst of the nuclear age, nuclear weapons tests were revealing many different potential electronic vulnerabilities and the prospect of exploiting them. In 1962, during the "Starfish Prime" testing of a 1.4 megaton nuclear device at 400 kilometers above the Johnston Atoll, the effects of an electromagnetic pulse (EMP) were felt as far as 1,400 kilometers away in the Hawaiian Islands (Ellis 2015). The effects were both new and significant: streetlights were shut off, alarms were set off, and even some low-Earth orbit satellites were damaged (Ellis 2015). These damage effects were confirmed when the Soviet Union detonated a series of 300 kiloton warheads in Kazakhstan (Ellis 2015). The need to develop weapons based on the effects of high-powered, pulsed electric fields became apparent, and while most of the developmental history of these weapons remains classified, it is clear that the concept began following Starfish Prime (Ellis 2015).

Also around the same time as Starfish Prime, the first ruby laser was constructed using hydrogen fluoride, and between 1960 and 1975, the peak power levels of this laser rose from 1 kilowatt to 100 kilowatts (Ellis 2015). By the early 1980s, the power level would reach 250 kilowatts in a joint Navy-Advanced Research Projects Agency (the fore-runner to the Defense Advanced Research Projects Agency, or DARPA), and this rapid rise gave way to more possibilities for weapons and research (Ellis 2015). In particular, during this height of the Cold War, the Navy was more and more interested in the use of high-energy lasers in the defense against ballistic missiles. However, as the Cold War ended in the late 1980s, so did the desire to fund many of the programs associated with directed energy and EMP technology (Ellis 2015). This is not to say that the programs ended all together, as progress continued in development which eventually resulted in the U.S. Air Force's Airborne Laser, a Boeing 747 aircraft fitted with a megawatt-class chemical laser in the early 2000s (Ellis 2015). This program, along with its companion Space-Based Laser program grew larger and larger until late in the decade the budgets were slashed by nearly 60% and both were cancelled due to lack of progress and field-able weapons (Ellis 2015).

In June 2009, the U.S. Navy successfully tested a 33-kilowatt fiber solid state laser weapon system against five unmanned aerial vehicle targets at a test site in China Lake, California (O'Rourke 2015). The same system was then outfitted on the destroyer *USS Dewey* (DDG-105) and successfully engaged three targets underway off San Diego in September 2012 (O'Rourke 2015). The Navy intends on testing a 100-kilowatt laser in the near future (O'Rourke 2015).

3. Benefits of High Temperature Superconductors to Navy Ships

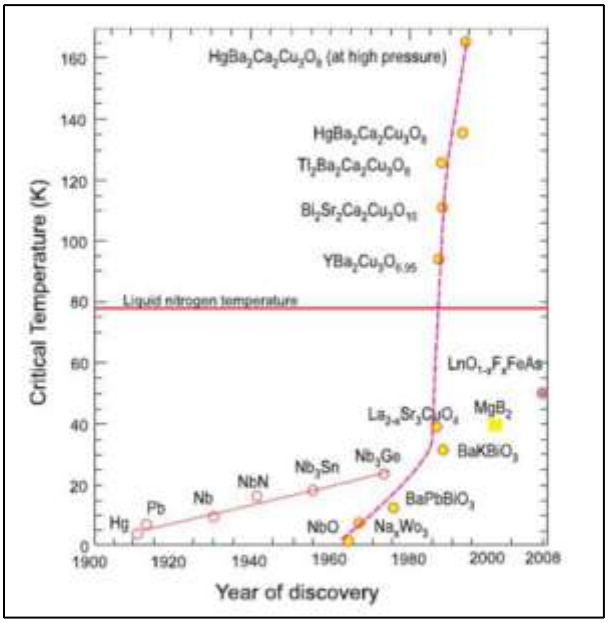
In 2008, the Office of Naval Research successfully installed and tested a High Temperature Superconductor degaussing system on *USS Higgins* (DDG-76) (Vietti 2009). This first-ever installation of an HTS system aboard a warship, as described by Commander Carl Meuser, commanding officer of *USS Higgins*, gives "us a great warfighting advantage going forward. This technology has a myriad of potential applications that will help make our U.S. Navy even more prepared to conduct prompt and sustained naval operations." (Vietti 2009). Brian Fitzpatrick, an engineer working for Naval Surface Warfare Center Carderock Division, stated that "the superconductivity of this new degaussing system means less energy is required, yet it enables greater degaussing performance. Additionally, there is significant weight savings—up to 80 percent in some cases." (Vietti 2009). Given the great success of the HTS degaussing system, the promise of applying this technology to the electric ship becomes a distinct possibility.

B. HISTORY OF SUPERCONDUCTIVITY

Superconductivity was officially discovered in 1911, when Kamerlingh Onnes, a Dutch scientist, found that the electrical resistance of mercury was reduced to zero when its temperature was reduced to 4.2 kelvin (-268.95 Celsius) through the use of liquid helium (Blundell 2009). What he would later find, through the same method, was that while mercury would become a superconductor at 4.2 kelvin, pure gold would not. Onnes first assumed that this was due to some peculiar property of mercury alone, but in 1912, he discovered that tin would superconduct at 3.7 kelvin and lead would do the same at a little over 6 kelvin (Blundell 2009).

The study of elements and compounds and their potential for superconductivity has continued since the discovery in 1911. Numerous theories on the subject have been proposed, confirmed, and disproven since then, with the biggest breakthrough in the field occurring in 1986, when J. Georg Bednorz and K. Alex Müller discovered through theory and testing a lanthanum compound whose resistance dropped to zero at 35 kelvin (Kruchinin, Nagao and Aono 2011). This discovery led to the current race for other compounds that become superconductors at higher temperatures. Since the initial discovery, the highest temperature that a compound will become a superconductor is 133 kelvin and is a mercury-barium based compound, which was discovered in the late 1990s (Kruchinin, Nagao and Aono 2011).

Figure 1. Superconducting Material Discovery over Time.



Source: Kruchinin, Sergei, Hidemi Nagao, and Shigeyuki Aono. 2011. M*odern Aspects of Superconductivity—Theory of Superconductivity*. Singapore: World Scientific.

The first official working application of a high temperature superconductor was on February 18, 2000, by Southwire Company, LLC (Oak Ridge National Laboratory 2000). Southwire tested a 30-meter length of high temperature superconducting power distribution cables, and carried up to 1250 amperes at 12.4 kilovolts using their proprietary cryogenic dielectric tape material (Oak Ridge National Laboratory 2000). The next significant installation was that by a cooperative effort led by Superpower, Incorporated, in 2006 in Albany, New York. In this system, the length of cable was 350 meters and operating at 34.5 kilovolts and 800 amperes (Weber et al. 2006). Shortly after this, Southwire again led a project in Columbus, Ohio, for a run of 200 meters and operating at 13.2 kilovolts and 3000 amperes (Southwire Company, LLC 2009).

The largest installation of high temperature superconducting cable in terms of length, scale, and power carried is that of the AmpaCity project in Essen, Germany, in May of 2014 (Nexans, S.A. 2012). This ceramic-based superconducting cable, at 15 cm in diameter, carries 40 megawatts at 10,000 volts along a distance of 1 kilometer in contrast to the conventional 110,000-volt copper power line (Nexans, S.A. 2012). This installation of the cable also allowed for the removal of several voltage step-down substations throughout the city (Nexans, S.A. 2012). As of October 2014, the cable has been providing power for around 10,000 households, approximately 20 million kilowatt-hours over the six-month period (Nexans, S.A. 2012). The cable remains in successful operation in November 2015.

C. HIGH TEMPERATURE SUPERCONDUCTORS

High temperature superconductors (HTS) are materials whose electrical resistance becomes zero at a temperature above 77 kelvin, and this temperature is important because it is the temperature at which inexpensive, safe, abundant nitrogen condenses to a liquid (Owens and Poole 1996). HTS are different from low temperature superconductors (LTS) in some very particular ways. To understand the differences, the anatomy of normal conductors and LTS materials must be understood.

As described in Owens and Poole's *The New Superconductors* (1996), materials are deemed conductors of electricity if, when given an electro-motive force, electrons will move throughout the material. It goes on to say that this electro-motive force is an applied voltage, and the electrons are carrying a negative charge, but conductivity is not a binary characteristic as different materials have varying levels of conductivity, and others are conductors only under certain conditions (these are semiconductors), and the level of conductivity is typically measured by its inverse, which is called its resistivity. Resistivity is the resistance of a material to conduct electricity. Copper, for example, has a low level of resistivity at 1.7 μΩ-cm while Mercury is a poor conductor with a resistivity of 96 μΩ-cm (Owens and Poole 1996). Copper's conductivity comes from the fact that each individual copper atom has one valence electron in its outer shell, which it can easily pass from itself to other copper atoms (for example), thus facilitating the flow of electrical current (Owens and Poole 1996). As further explained in *The New Superconductors* (1996), when copper atoms are combined into solid copper, the atoms will arrange themselves into a cubic crystal lattice. Under these conditions, it says, the valence electrons of all of the atoms remain rather equally distributed. However, the electrons can flow between each of the atoms of copper, and when an electromotive force is applied, the electrons will move to the side of the wire with the least amount of negative charge (Owens and Poole 1996).

The individual atoms that make up the crystal lattice of solid copper are not fixed in their position, but instead vibrate and oscillate around the equilibrium regions of the lattice (Owens and Poole 1996). These vibrations are due to the average kinetic energy of the atoms, which can be measured by its temperature, and as the temperature of the atoms is increased, so does the vibration and motion of the atoms (Owens and Poole 1996). This movement of the atoms can interfere with the free-flow of the electrons, thus increasing the resistivity when the temperature increases and decreases with the decrease in temperature of copper (Owens and Poole 1996). When all kinetic energy is removed from the material and the atoms cease their vibrations then absolute zero, or zero kelvin has been reached. (Owens and Poole 1996).

Continuing from *The New Superconductors* (1996), when Onnes first liquefied helium at 4.2 kelvin in 1911 and then exposed liquid mercury to it, the mercury’s resistance reduced to zero without reducing the temperature to zero kelvin. This temperature is known as a critical or transition temperature and several transition temperatures for various materials can be found in Table 1 (Owens and Poole 1996).

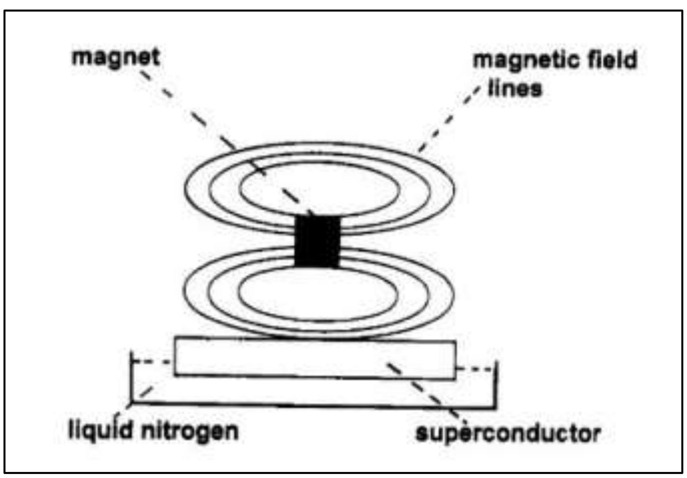
Table 1. Elements and Their Critical Temperatures

Element	**Symbol**	**Critical Temperature (Kelvin)**
Cadmium	Cd	0.52
Zinc	Zn	0.85
Aluminum	Al	1.2
Tin	Sn	3.1

Adapted from: Owens, F. J. and C. P. Poole. *The New Superconductors.* New York: Kluwer Academic Publishers, 1996

According to *The New Superconductors* (1996), in 1933, Alexander Meissner and R. Ochenfeld discovered another peculiar characteristic of a superconducting material—magnetic fields do not penetrate them. Furthermore, when Meissner and Ochenfeld placed a metal into a magnetic field, and then lowered the temperature to the metal's critical temperature, they discovered that the magnetic flux through the metal was reduced to zero, and this is now known as the Meissner Effect (Owens and Poole 1996). The Meissner Effect would also cause a relatively small magnet placed on top of a superconductor to levitate as the superconductor repelled magnetic fields (Owens and Poole 1996). This can be seen in Figure 2.

Figure 2. Levitation Effect of Superconductors



Source: Owens, F. J., and C. P. Poole. *The New Superconductors.* New York: Kluwer Academic Publishers, 1996

Continuing in *The New Superconductors*, along with the Meissner Effect, it was discovered that when a material is in a superconducting state, if exposed to a magnetic field beyond a certain threshold then the material would fall out of its superconducting state. Given the maximum magnetic field, called the Critical Magnetic Field, there had to have been a corresponding maximum current, which is called the Critical Current Density (Owens and Poole 1996). This means that there are three limits for a superconducting material: the Critical Temperature, Critical Magnetic Field, and Critical Current Density (Owens and Poole 1996).

High temperature superconductors have all of the same properties as their low temperature counterparts but are different in how they allow electrons to flow without resistance (Owens and Poole, 1996). In the former, the electrical resistance is removed by reducing the vibrations of the current carrying substance being cooled, while in the latter the vibrations remain but are controlled due to the relatively rigid, flat crystal lattice structure of their compounds. It is this complex crystal lattice that allows supercurrent to flow as it does, and explains why after their discovery in 1986 the compounds became more complicated than prior superconductors (Owens and Poole, 1996).

The New Superconductors (1996) described the crystal lattice of HTS materials as very unique. In order to maintain the structure necessary to remove resistance, it says, multiple compounds must be layered together in order to maintain the flat and planar 'channel' that the current flows through. This "channel" is called the conduction layer, and is sandwiched between two binding layers and in the case of the popular HTS compound, $YBa_2Cu_3O_7$, (Yttrium-Barium-Copper-Oxide, or YBCO), the copper oxide forms the conduction later while the yttrium and barium provide the binding layers (Owens and Poole 1996). In this material the maximum number of copper oxide layers is two, which when assembled, forms a sort of thin, flat ribbon or tape look, and this form of superconductor is both practical and efficient, which results in it being quite popular for manufacturing (Owens and Poole 1996). The YBCO compound is of particular interest because it has a critical temperature over the temperature of liquid nitrogen, and the elements it is comprised of are particularly cheaper to obtain than alternatives (Owens and Poole 1996).

It is important to note, however, that the concept of a high temperature superconductor was realized before it was synthesized. In 1986, the lanthanum compound that Bednorz and Müller discovered as a superconductor, $La_2Sr_3CuO_4$, (Lanthanum Strontium Copper Oxide, or LSCO), when cooled to approximately 40 kelvin (which is well below the boiling point of liquid nitrogen) behaved according to the crystal lattice method rather than that of the reduced vibrations (Owens and Poole 1996). Based on this realization, in 1987, Bednorz and Müller designed and successfully tested the YBCO compound, which behaved in the same manner, though many kelvin above the boiling point of liquid nitrogen (Owens and Poole, 1996).

D. CURRENT AND POTENTIAL STAKEHOLDERS

In addition to navies around the world being interested in high temperature superconducting cables, the commercial shipbuilding industry will also have a stake in the progress and advancement in electric power transmission. Furthermore, the energy industry is pioneering the use of high temperature superconducting cables for energy transmission for urban infrastructure.

II. GOLDFIRE INNOVATION TECHNOLOGY

A software tool, IHS Goldfire Cloud Connect, allows users to perform searches of patents, articles, deep web information, and more. This software is used in an attempt to identify trends in the HTS technology area.

A. BACKGROUND

IHS began in 1959, according to their homepage, "as the Information Handling Services, founded by Richard O'Brien, as a provider of product catalog databases on microfilm for aerospace engineers" (IHS, Incorporated 2015). It goes on to say that "in 1967, Information Handling Services" became "part of the Indian Head Company" which was well known as a diversified company in metal and automotive products and specialty textiles (IHS, Incorporated 2015). They then began amassing several documenting companies, and in 1985, their website continues, began "producing engineering information databases in electronic format for PCs," distributing information via CD-ROM (IHS, Incorporated 2015). In an effort to increase access to the accumulated knowledge databases, Information Handling Services "begins marketing online versions of its information databases, making products easily accessible and easily update-able" in 1995 (IHS, Incorporated 2015). Then in 2004 Information Handling Services becomes IHS, Incorporated, and in 2005 IHS becomes a publicly traded company under the New York Stock Exchange symbol IHS. In 2007, IHS acquired the Jane's Information Group, well known for its impartiality of information and advice on governments and militaries worldwide. Finally, in 2012, IHS acquired Invention Machine, Incorporated, which was well known for their Goldfire search software. Over the past sixty-five years, IHS has acquired a significant number of other database organizations and companies and have consolidated under the name of IHS, Incorporated to become a premier research firm (IHS, Incorporated 2015).

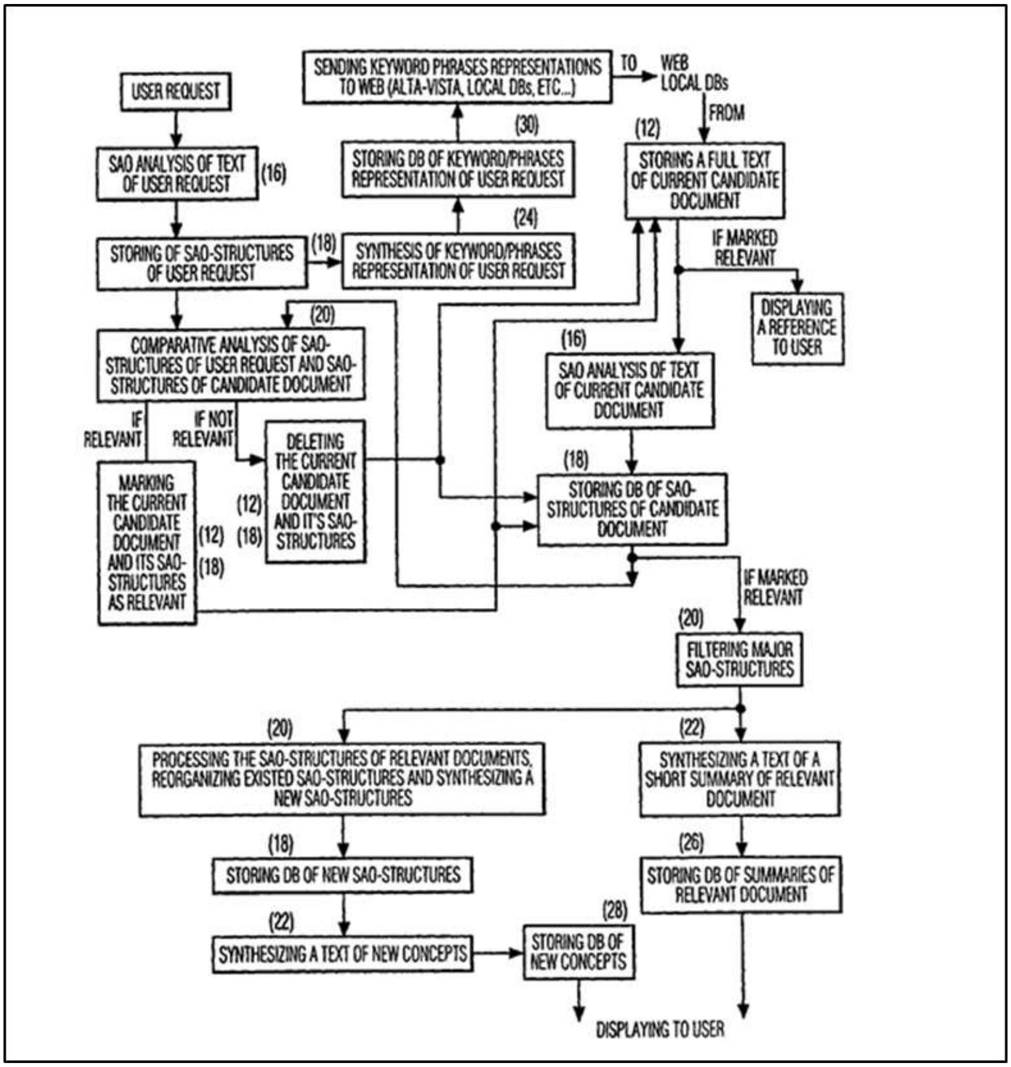
B. SOFTWARE EVOLUTION

The IHS Goldfire Cloud Connect 10.2 is the latest iteration of the proprietary research engine originally designed and developed by Invention Machine in 2004 as the

Goldfire Innovator (Henry 2004). Goldfire Innovator was designed as a front-end Product Life cycle Management tool, providing a “dashboard” of “comprehensive functions and content [to] aid the innovation process” (Henry 2004). This initial program had Invention Machine’s renowned and unique semantic knowledge retrieval and patent search capabilities.

The semantic knowledge retrieval is a search tool designed to interpret the user’s search criteria based on their March 16, 2000, patent number 6,167,370, which begins to solve a common Internet search problem. When a user performs an Internet search on a normal search engine, it is likely that the majority of the results will be unrelated to the user’s intent, as a traditional search involves an exact match of a word without reference to its context. What the Invention Machine’s patented search technology does is to determine the definition of the word or meaning of a series of words being searched for in a linguistic subject-action-object manner. When the software identifies other potential search terms or phrases that the user may be searching for, the system will search for those as well. Additionally, the same semantic analysis is conducted on the potential search results that are found, and will compare those results semantically to the original search terms to determine relevancy. Anything deemed relevant will be presented to the user while all other results are discarded. The remaining results are then scanned by the system and a summary is generated based on its contents to be presented to the user. These summaries can be read, printed, saved or discarded by the user. A model of this process can be seen in Figure 3. This search engine is specifically designed to be used for research with primary results being engineering papers, technical documents and other documented research. (Invention Machine 2000).

Figure 3. Diagram of Invention Machine's Semantic Search System



Source: Tsourikov, Valery M., et al. Document Semantic Analysis/Selection with Knowledge Creativity Capability Utilizing Subject-Action-Object (SAO) Structures. U.S. Patent 6,167,370, filed May 27, 1999, and issued December 26, 2000.

Invention Machine produced updated versions of the Goldfire Innovator software with improvements that included additional access to document repositories and improved semantic algorithms and anaphora resolution, which automatically resolves noun and pronoun ambiguity in a document (*Business Wire* 2006). A significant software advancement was achieved in 2007 when release 4.0 was made available, which enabled a cross-language semantic search in English, French, German, and/or Japanese (Henry, Invention Machine Announces Availability of Goldfire Innovator 4.0 2007). Goldfire

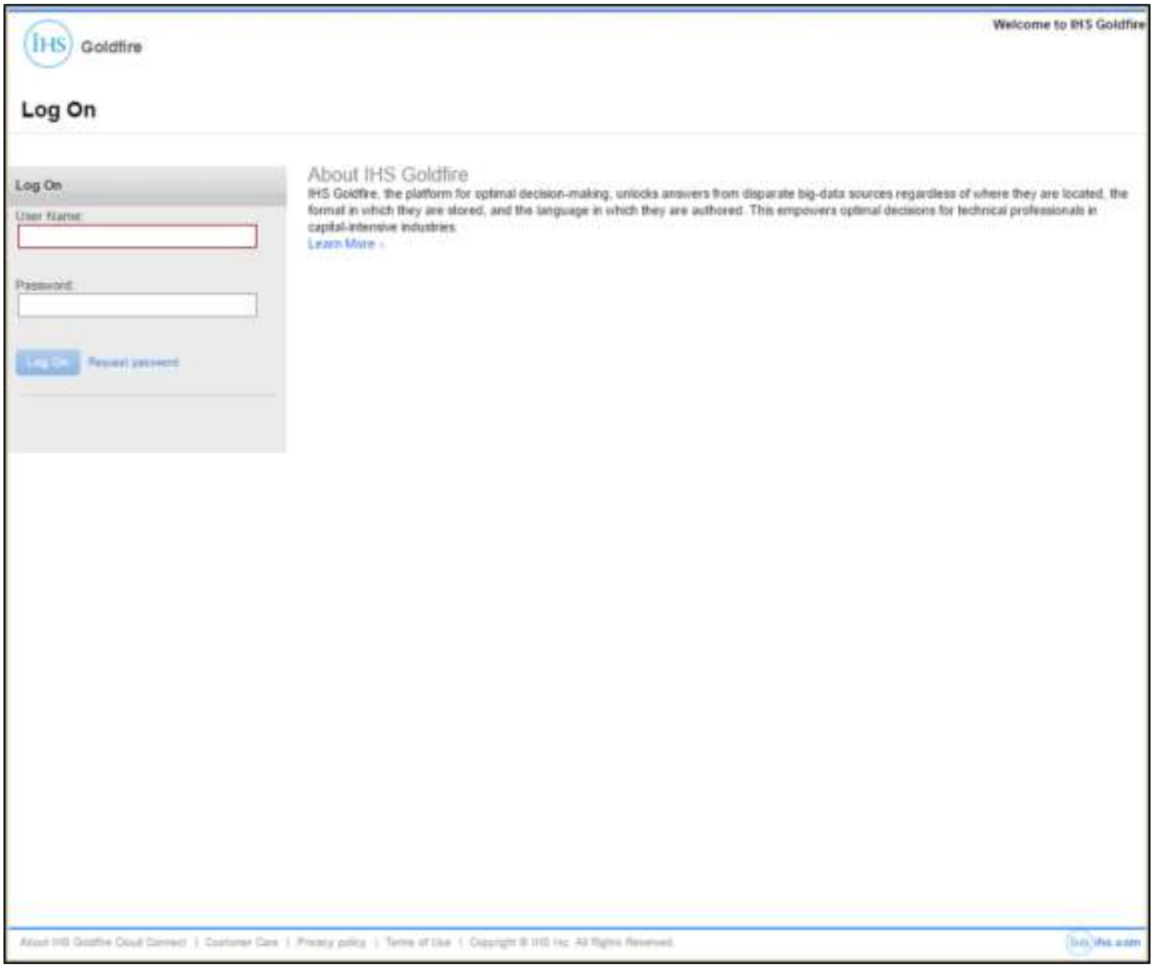
Innovator 6.6, released in 2011, provided optional email notifications of updates to search results (*Marketwire* 2011). Shortly after the company's acquisition by IHS in 2012, Invention Machine released Goldfire 7.5, which added support for tablet computers and semantic searches in Mandarin Chinese.

IHS released a stand-alone, online, cloud-based version of the Goldfire software in 2013 dubbed the IHS Goldfire Cloud Connect. This version was markedly improved over previous editions, as no additional software installation was needed. Using the Goldfire Cloud Connect software allowed users to access over 90 million scientific and technical documents including patents, premium IHS and third-party content and deep web sources using precise semantic searches (IHS Media Relations 2013). The current version of the software is 10.2, released in early 2015 and provides improvements such as advanced search and filter capabilities.

C. SOFTWARE FEATURES

IHS Goldfire Cloud Connect is accessed via the Log On page at https://gfh1.goldfire.com/ using validated user credentials. This can be seen in Figure 4. The Naval Postgraduate School's Department of Systems Engineering purchased a license with access for three individual accounts. The following is a brief walkthrough of some of the key software features that a user will encounter.

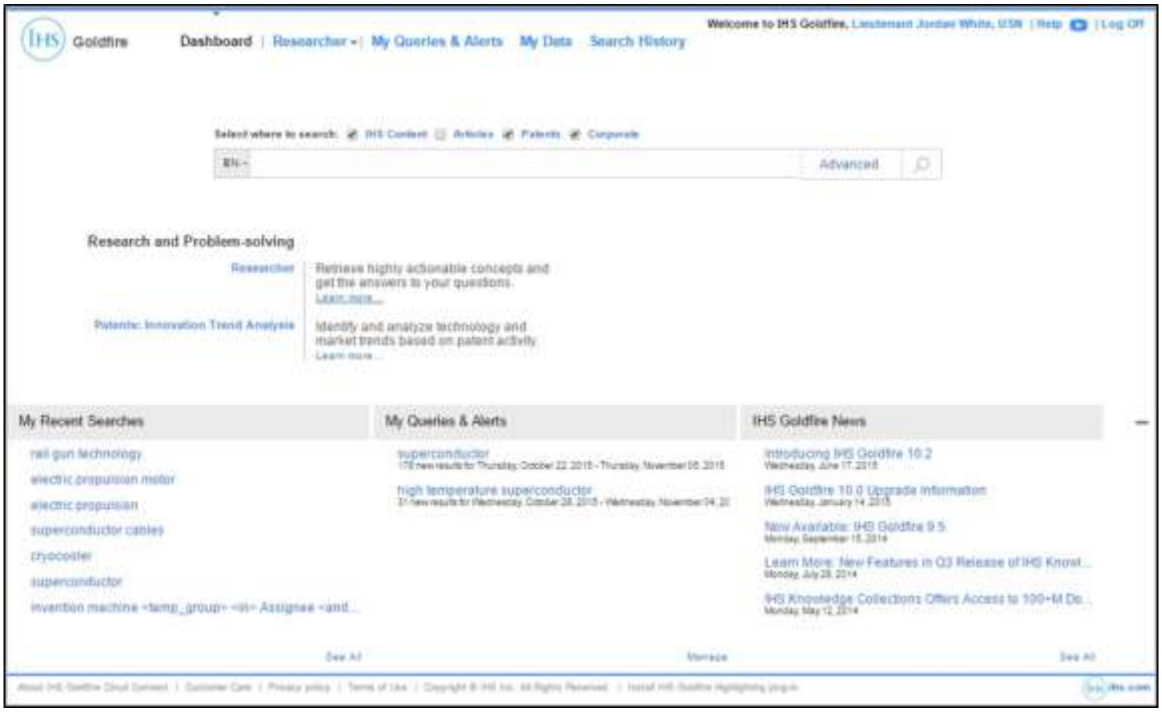
Figure 4. IHS Goldfire Cloud Connect Log On page



1. Dashboard

Upon a successful logon, the user is brought to the home screen, or Dashboard. From this page, shown in Figure 5, the user can find multiple options for researching across the top of the page, a simple text box for entering search terms in the middle of the page, the two options for search types (Researcher and Patents: Innovation Trend Analysis), and user-specific search information toward the bottom of the page.

Figure 5. Goldfire Cloud Connect Dashboard

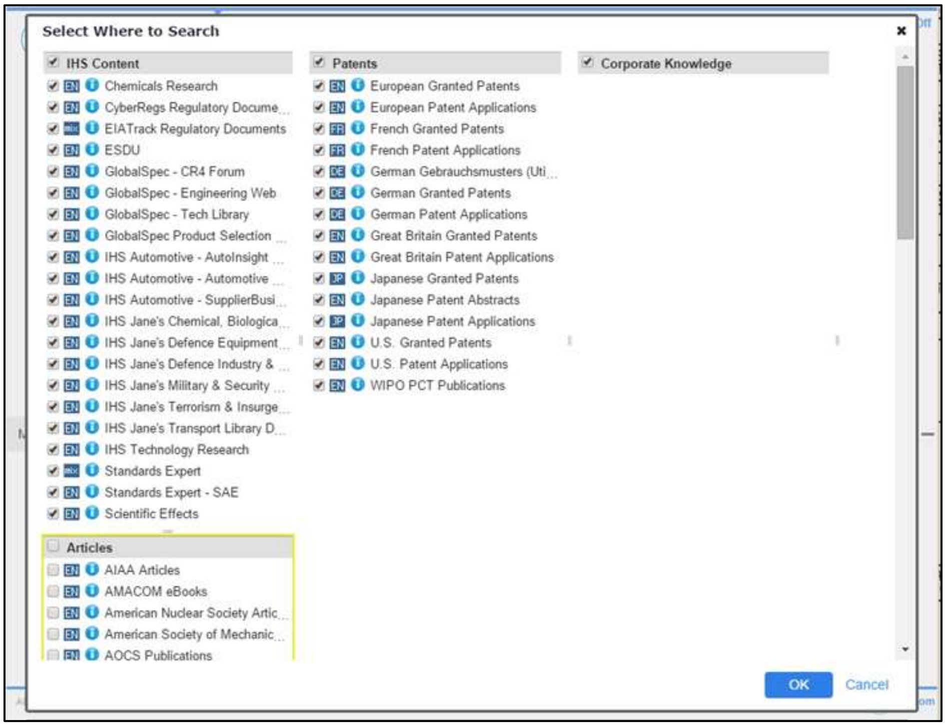


The Dashboard is the starting place for any and all research. As such, everything begins here. Additionally, the default setting of the Dashboard is to begin in the Researcher functionality. By clicking on the downward pointing arrow next to the Researcher tab the secondary option of Patents: Innovation Trend Analysis (PITA) like shown in Figure 6.

Figure 6. Dashboard Options

Above the text search box are four checkboxes for where to perform the search. By clicking on any one of the blue texts, another window overlay appears allowing the user to select or deselect specific search sources. This menu is shown in Figure 7.

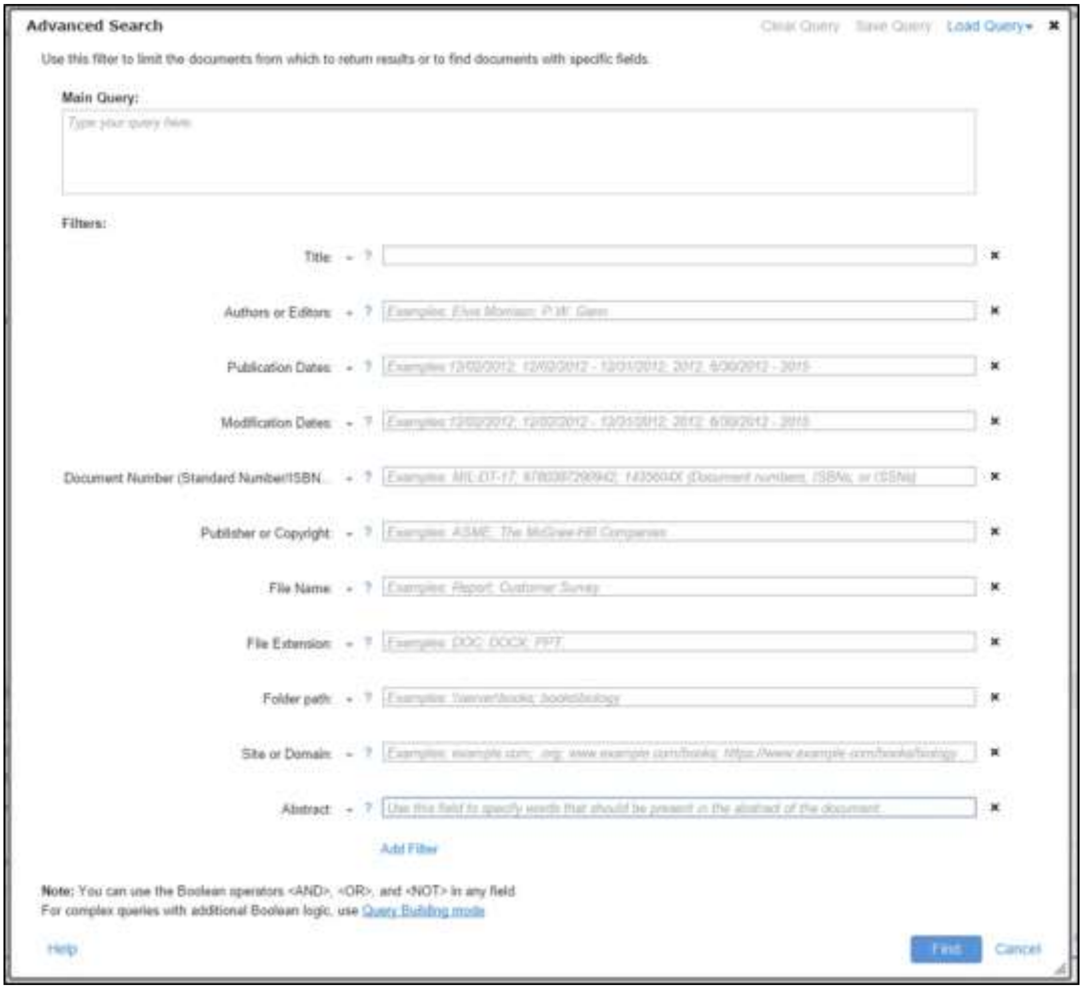
Figure 7. Dashboard Select Where to Search Menu



In the Select Where to Search menu, the user can select any or all of 21 different IHS Content sources, 16 patent sources, 71 different Article sources and that of Corporate Knowledge.

Similar to the Select Where to Search menu, the user can click the Advanced search options to the right of the text search box. The Advanced search options provide filters to "limit the documents from which to return results or to find documents with specific fields" as the menu states. The filters listed can be removed, or by clicking on the Add Filter link at the bottom a series of additional optional filters will be added to the menu. This can be seen in Figure 8.

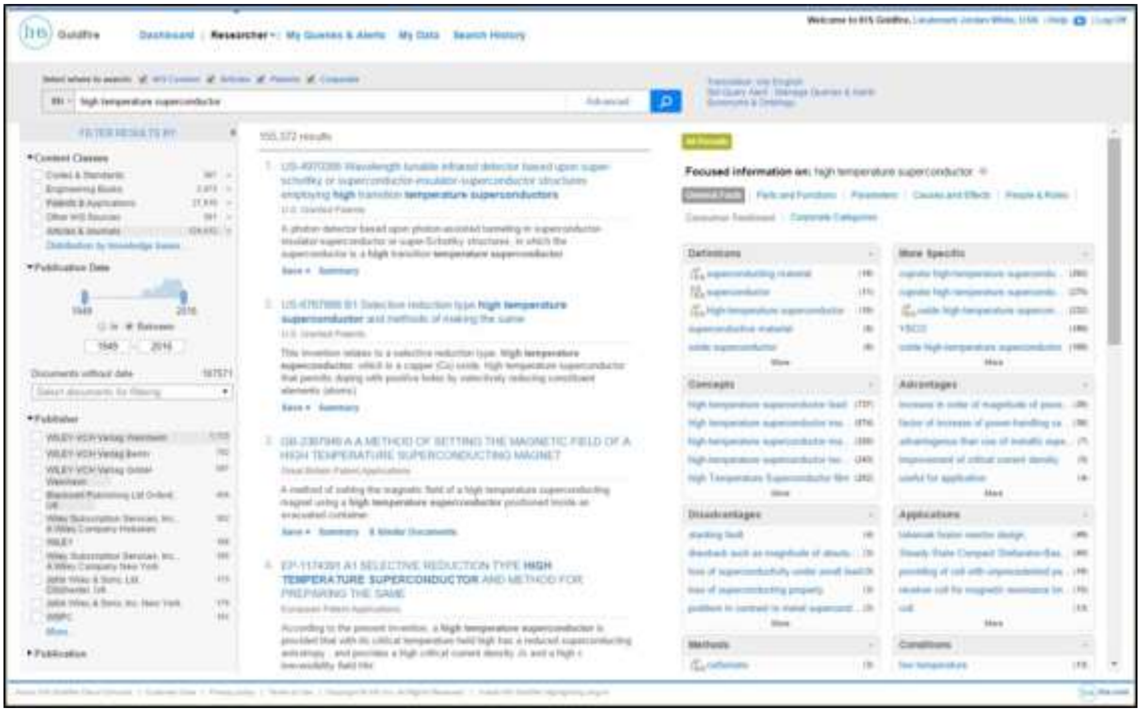
Figure 8. Advanced Search Options Menu



2. Researcher

The Researcher tab is very similar to the Dashboard tab and provides nearly all of the same options. Upon entering a search term, the main Researcher results screen appears as shown in Figure 9. In the far left column the user can find useful filters including the Content Classes, Publication Date, Publishers, Publication, Author, Knowledge Collections, Modification Date, and Site or Domains. Behind each of the result filters are bar graphs indicating the relative weight of each of the category's result. In the center column are the individual results, their class, a link to save the result into the user's My Data depository, and a link to a Goldfire-generated Summary of the result. The right column provides additional related search terms that are derived from the semantic search technology and can be customized by selecting some of the options under the focused information title.

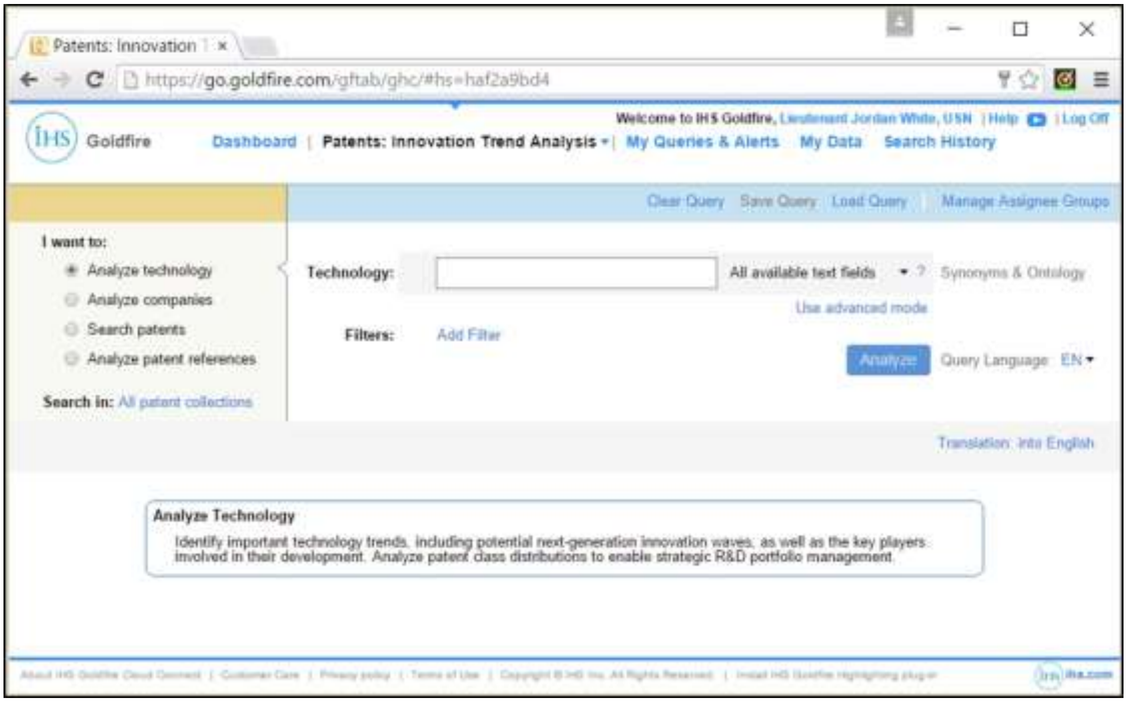
Figure 9. Researcher



3. Patents: Innovation Trend Analysis

The PITA provides a significant number of analytical tools to discover and identify technology trends. This can be done by analyzing the technology, companies, patent references or by searching the patents themselves. Filters can also be applied using either the advanced mode using Boolean code or by adding specific filters themselves. All of these options can be seen on the PITA page shown in Figure 10.

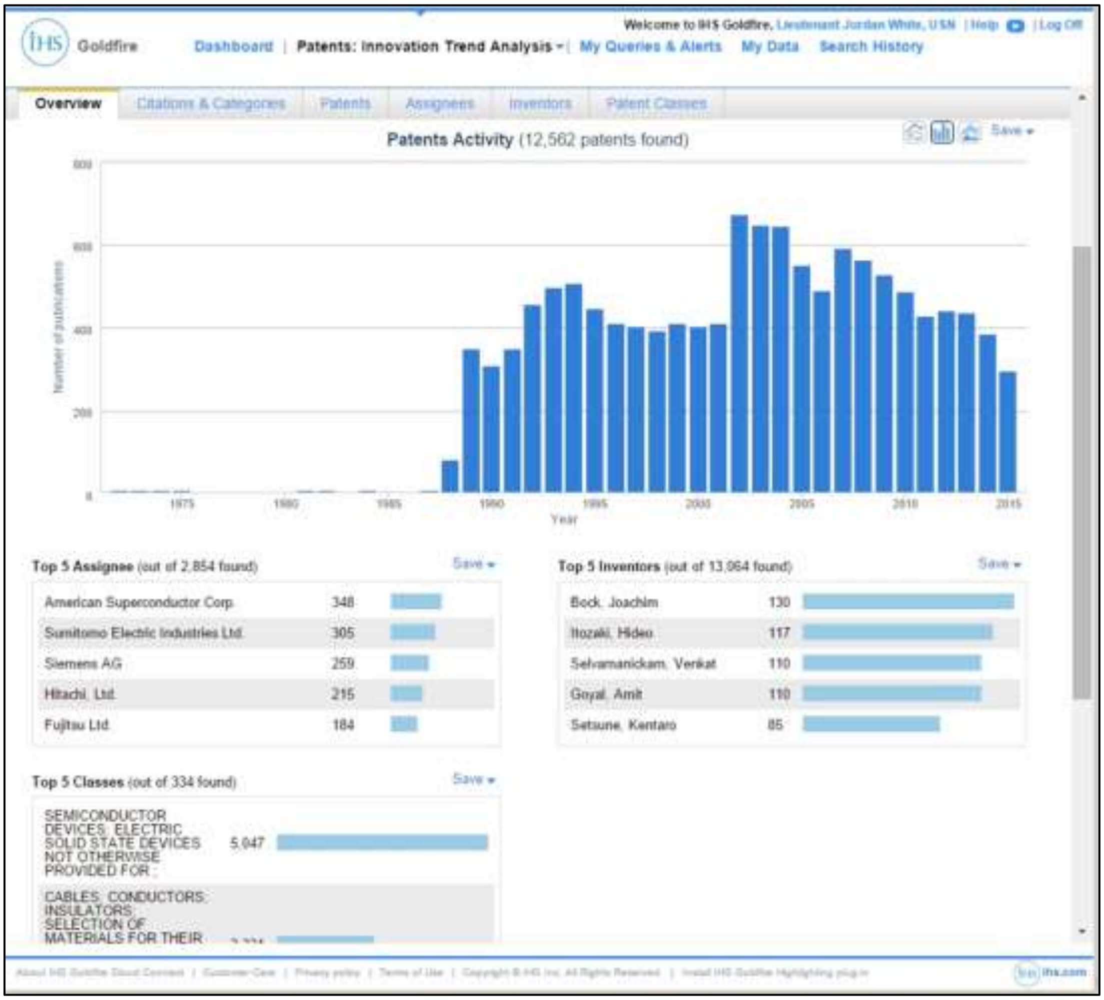
Figure 10. Patents: Innovation Trend Analysis Main Page



Upon completing a search, the search results tabs are displayed with the user being presented the Overview first. This screen can be found in Figure 11. The primary display is that of the Patent Activity over time in the default bar graph style. This style may be changed to line graph or shaded line graph by using the miniature icons in the top-right corner of the graph display.

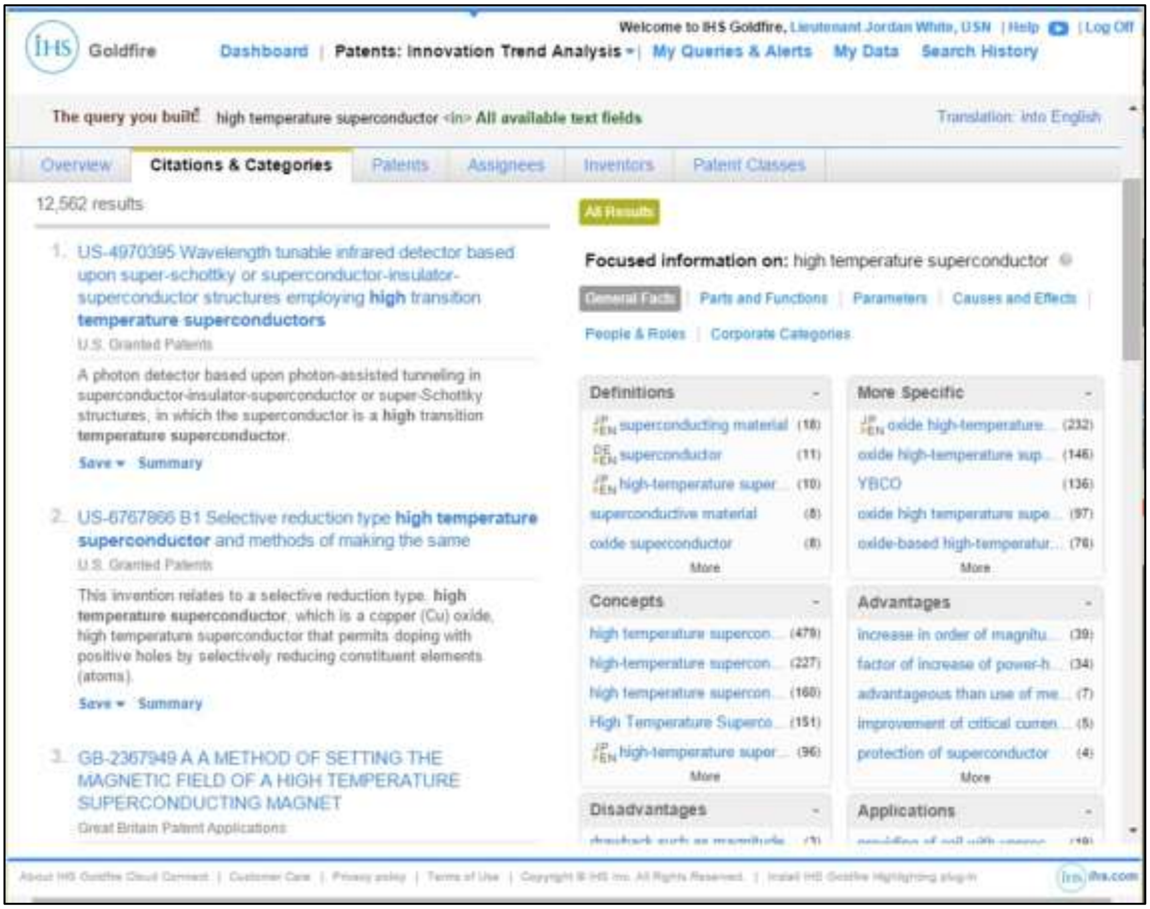
Below the Patent Activity graph are the top five of three different categories: the Assignees, Inventors, and Classes. The Assignees are those organizations or groups that are given the patent by the inventor of the patent. The Inventors are the actual persons who the patents were granted. The Class of the patent is the category of the patent itself.

Figure 11. Patents: Innovation Trend Analysis: Overview and Patents Activity



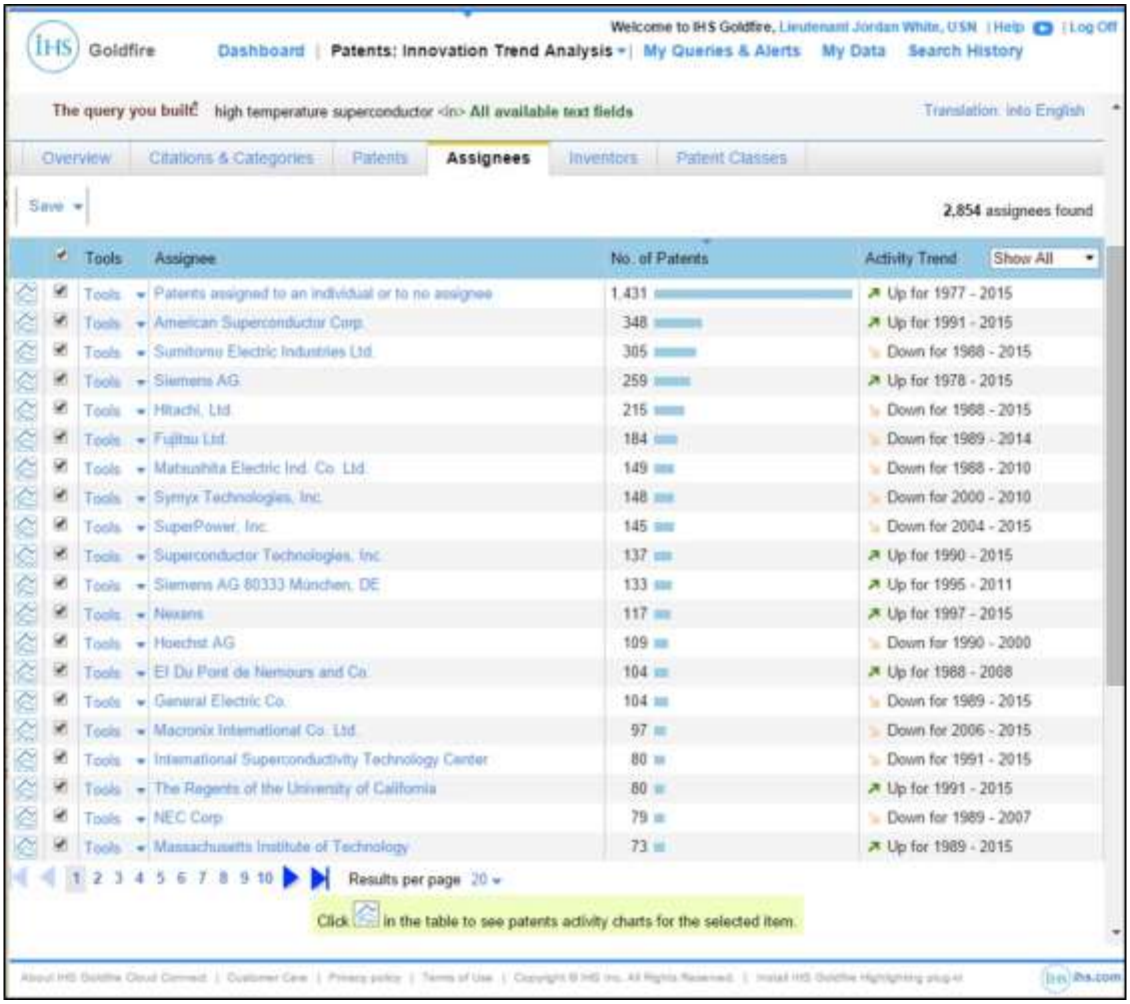
In the next tab over, the Citations & Categories, the user can find a page similar to that of the Researcher search tool, but specifically for Patents and without the available filters. This tab is meant to assist the user in refining their search for specific patents or concepts. This can be seen in Figure 12.

Figure 12. Patents: Innovation Trend Analysis: Citations and Categories



In the next tab, Patents, is simply a list of all of the Patents, their publication numbers, assignees, and titles. Similarly, the Assignees tab is a list of all of the assignees, the number of patents that they have had published, and the most recent activity trends. A screenshot of the Assignees tab can be found in Figure 13.

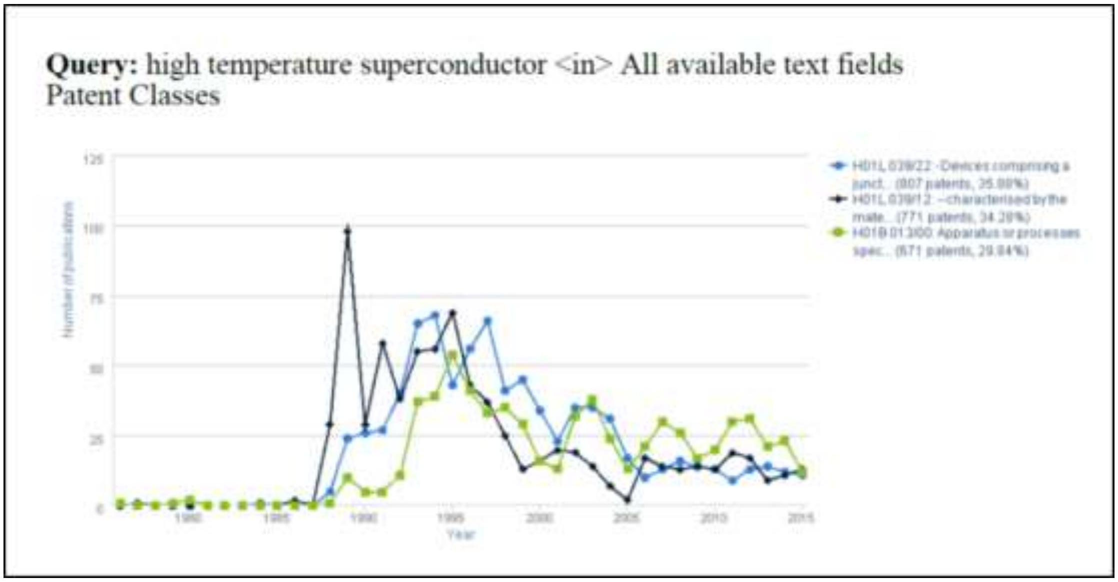
Figure 13. Patents: Innovation Trend Analysis: Assignees Tab



The Patent Classes tab displays a similar statistics as the last three tabs, but in reference to the category of each patent issued.

From each of the tabs, data may be saved to the My Data section where it may be recalled, reviewed, downloaded, and exported to Portable Document Format (PDF) or Microsoft Excel spreadsheet or Word document. An example of the data that can be exported can be seen in Figure 14, an export of activity trends of three different selected Patent Classes.

Figure 14. Exported Data of Patent Classes Trends of Three Selected Classes



D. MILITARY AND COMMERCIAL APPLICATIONS

While Goldfire Cloud Connect was designed specifically for researchers in primarily engineering fields, it is useful for any individual or organization that conducts development from the ground level. There may be limited utility for a typical military officer, as the primary purpose of this software is research for development. This software is especially worthwhile for those military officers who are in the graduate academic setting, such as those assigned to the Naval Postgraduate School and the Air Force Institute of Technology. To realize the true benefit of the article search, though, the user must have account access to all of the search sources. This limitation can also be minimized by deselecting each of the restricted article sources.

III. HTS-RELATED PATENT TRENDS

A. PROCESS

This research was accomplished by searching through published patents to determine trends in HTS technology. The search was constrained to only patents and only through the use of the IHS Goldfire Patents: Innovation Trend Analysis search software. No specific details or requirements for projected U.S. Navy technology were considered. Furthermore, patent abstracts were reviewed to verify their significance and relevance to the research. All data is available in the Appendix.

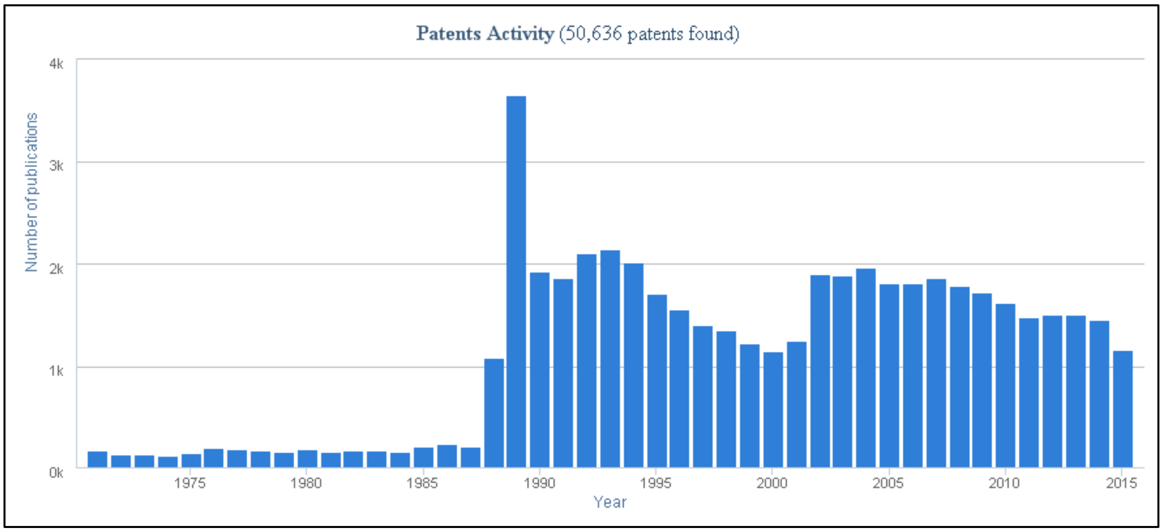
To begin the process of the research, concise and direct search terms and criteria were selected to collect the necessary data to evaluate. The data specifically is the number of patents published in a given year in the field of HTS since the discovery of the concept in 1986, but will not be constrained to patents since then as certain technologies such as cryogenic cooling has existed since long before that time.

B. SEARCH CRITERIA

In order to find the relevant data for review and consideration, the appropriate Search Criteria must be used to find the appropriate patents. Search Criteria that is too vague will result in too many irrelevant results while Search Criteria that is too specific will result in too few results. While the field of HTS cables is wide in its scope of technologies, the search is broken into two specific categories: HTS Cables and HTS Cooling.

To gain a broad perspective of the potential patents that are involved, a search of patent trends using the single criteria “superconductor” in all available text fields was performed, and the Patent Activity in Figure 15 was the result.

Figure 15. Search Criteria Superconductor in All Available Text Fields



Two distinct points are noticeable in this figure: in 1989, when activity was greatest and in 2002, when activity increased 60% between 2000 (1140 patents) and 2002 (1886 patents). The top patent class was that of H01L 039/24, which is, "Processes or apparatus specially adapted for the manufacture or treatment of devices for in group H01L 39/00 or of parts thereof," where H01L 39/00 refers to "devices using superconductivity or hyperconductivity; processes or apparatus specially adapted for the manufacture or treatment thereof or of parts thereof." Plotting the trend of the top patent class and that of the trend of H01B 012/00 ("Superconductive or hyperconductive conductors, cables or transmission lines;) provides the results shown in Figure 16.

Figure 16. Search Criteria “Superconductor” in All Available Text Fields with Top Patent Class H01L 039/24 and H012/00

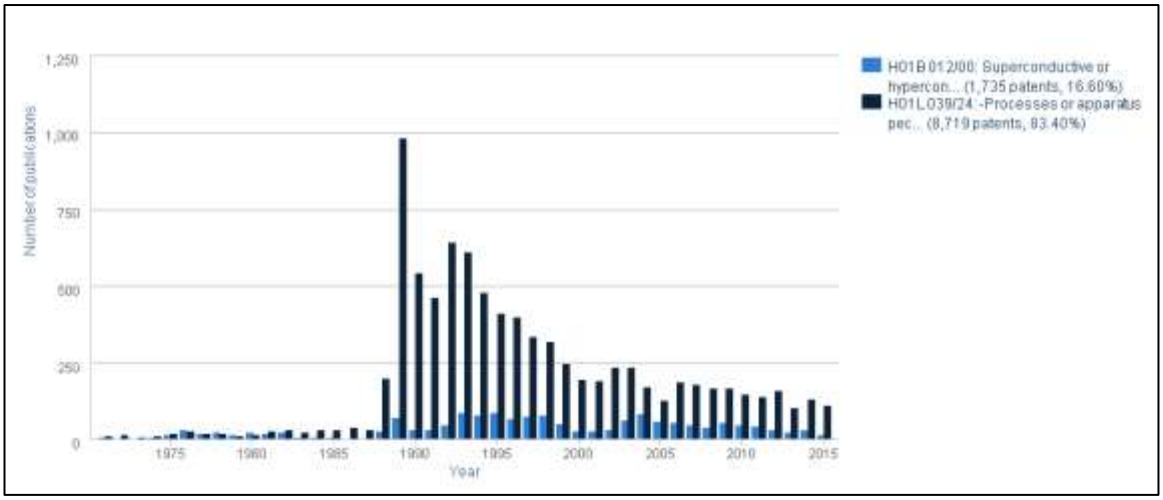


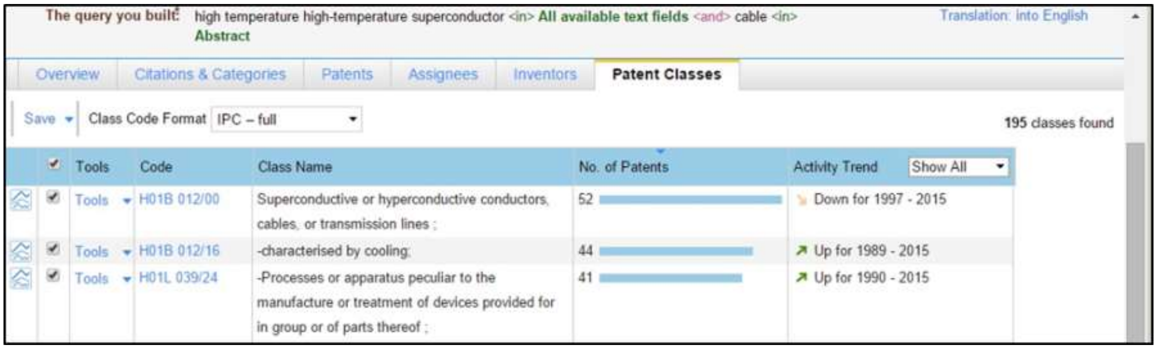
Figure 16 identifies the number of patents over time of the top patent class “Processes or apparatus specially adapted for the manufacture or treatment of devices for in group H01L 39/00 or of parts thereof” and “Devices using superconductivity or hyperconductivity; Processes or apparatus specially adapted for the manufacture or treatment thereof or of parts thereof” using the search criteria “Superconductor” in all available text fields.

The research was broken into two separate categories: High Temperature Superconducting Cables and High Temperature Superconductor Cooling. These categories were selected because HTS Cables are the focus of the research and HTS Cooling is both necessary for HTS Cables to operate and provide an indication of the HTS technology development as a whole.

1. High Temperature Superconducting Cables

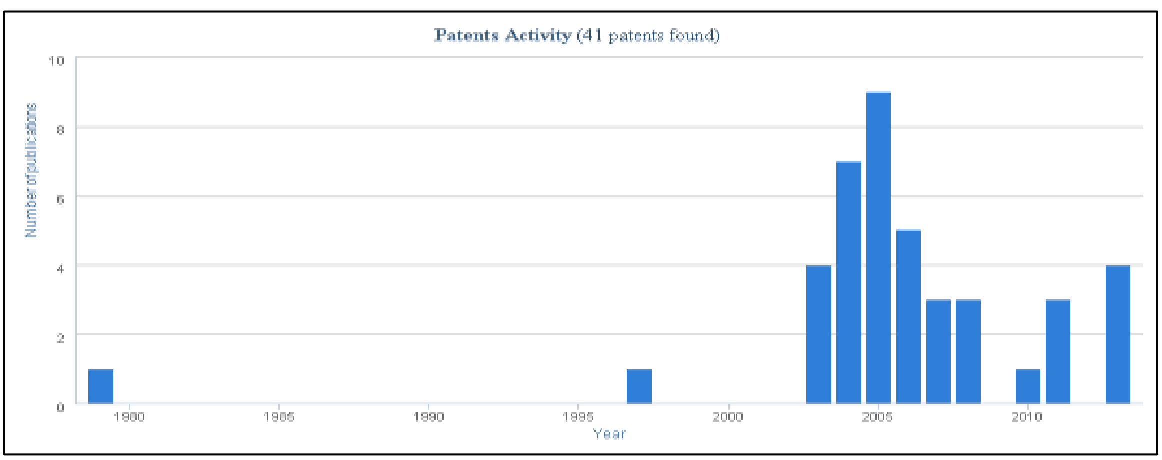
The research begins in the Patents: Innovation Trend Analysis portion of the software under the “Analyze technology” searches. The search began with the obvious “high temperature superconductor,” which with the Goldfire search technology includes “high-temperature superconductor” and “HTS.” The filter of “cable” was also added to search in the abstract of any results found. Under the Patent Classes tab, the top classes were “Superconductive or hyperconductive conductors, cables, or transmission lines,” and two of its subclasses “-characterized by cooling,” and “-Processes or apparatus peculiar to the manufacture or treatment of devices provided for in group or of parts thereof," as shown in Figure 17.

Figure 17. Top Patent Classes Under Listed Search Criteria



This first Class is the main topic of this research, and by selecting this code H01B 012/00 the Goldfire software added this code to the search filters and provided the results for them. This search criterion yielded only 41 resulting patents between 1979 and 2015, with the most patents being granted in 2009, with nine total, and the most recent four patents all granted in 2013.

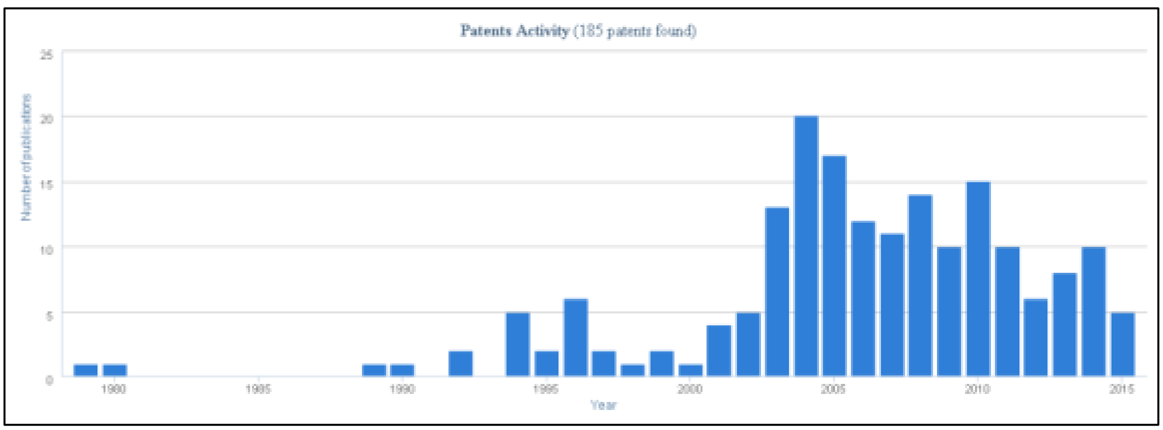
Figure 18. High Temperature Superconductor Cable Patents of IPC Class H01B 012/00 with "Cable" in the Abstract



Of the 41 patents shown in Figure 18, only two mentioned specifications of the inventions that the patents described. Of those two, U.S. patent 09047961 by the Massachusetts Institute of Technology (MIT) claimed a maximum current throughput of 54,000 amps at 4.2 kelvin (presumably using liquid helium) and 32,000 amps at 77 kelvin (presumably using liquid nitrogen), and U.S. patent 8442605 B2 by NKT Cables Ultera A/S whose invention claimed a current throughput of 4,000 amps. While the MIT patent listed significantly higher amperage capacity than that of the NKT patent, MIT did not include any voltage specifications of their proposed cable. Meanwhile, the NKT patent includes a voltage specification of 13.2kV which overall could provide a total power transfer of 52.8 megawatts (MW).

By removing the filter of "cable" being searched in the abstract of the patent a total of 185 patents were found as shown in Figure 19. These results also include the 41 patents previously mentioned, but reveal that the greatest number of patents approved in a year was 2004 with 20 patents.

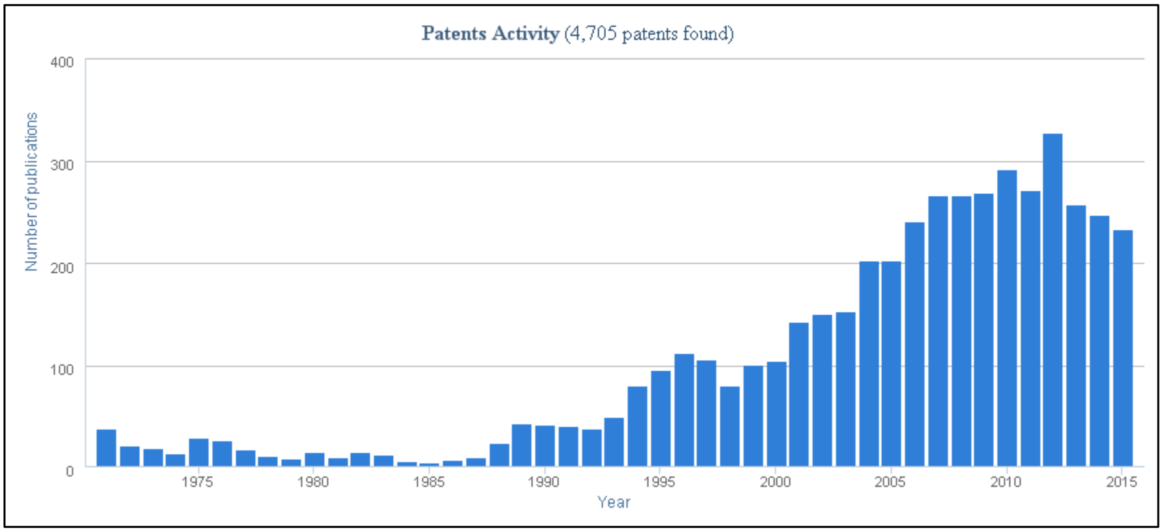
Figure 19. High Temperature Superconductor Cable Patents of IPC Class H01B 012/00



While this produces a four-fold increase in results, a review of the additional patents provided no additional relevant results. That is to say, there were no results that were overlooked through the use of the filter "cable" in the abstract.

Starting a new search with criteria of “superconducting cable” resulted in 4,705 patents being found between January 1970 and November 2015. The greatest individual year with patents meeting that search criteria was 2012 with 327 patents being approved and 212 patents being approved in 2015 as shown in Figure 20.

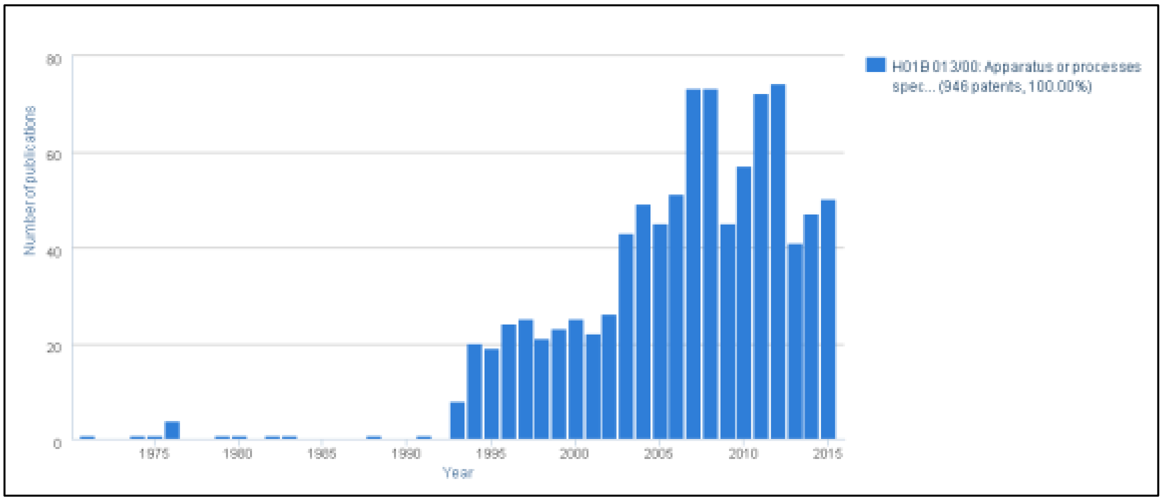
Figure 20. Patent Trends for Search Terms “Superconducting Cable”



The greatest assignee of patents found under the “superconducting cable” criteria is Sumitomo Electric Industries, Ltd., which holds over 1,135 of the 4,705 patents (24.1%) under the names “住友 電気 工業 株式 会社” (which is Japanese for Sumitomo Electric Industries, Ltd.), “Sumitomo Electric Ind. Ltd.,” and “Sumitomo Electric Industries, Ltd.”

The most significant finding from this search is that the patent class that is most represented from this search is that of IPC Code H01B 013/00, which is named “Apparatus or Processes specially adapted for manufacturing conductors or cables,” which has shown an upward trend between 1971 and 2015 as shown in Figure 21.

Figure 21. Patent Class H01B 013/00 Trends Over Time

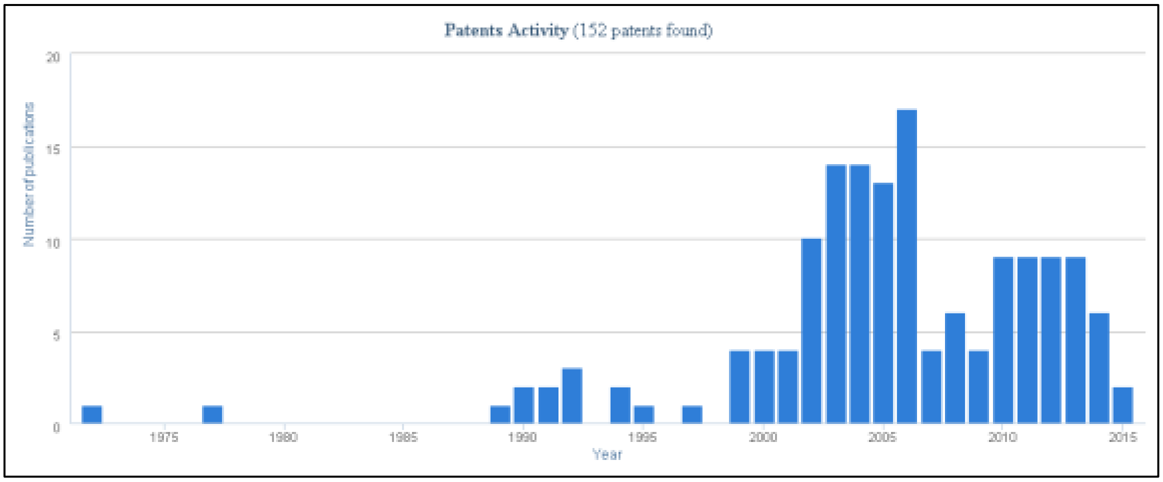


As shown, there has been an appreciable increase in H01B 013/00 patents starting in 1993 and peaking in 2007, 2008, 2011, and 2012. This is significant because it could be assumed that it would be these patents that would provide the capability to produce the necessary cables and cable equipment that would be used. But when considering the implications of manufacturing process patents it would suggest that superconducting cable-related patent trends would be unaffected by them, but instead the manufacturing processes would be affected by trends in patents in superconducting cables.

Upon further review, it was found that "superconducting" was being used by the Goldfire software as a descriptor and thus was not searched with any synonyms or ontological variation. By changing the search criteria to "superconductor cable" with the filter of H01B 013 patents in the IPC class, the total results plummeted to only 10 patents between 1979 and 2015 in regards to manufacturing processes and superconductors.

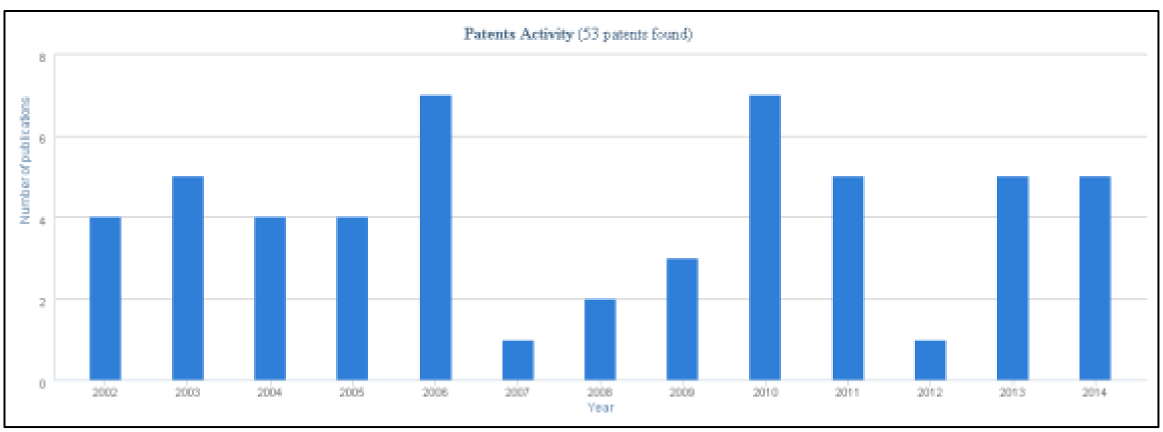
Beginning again the search criteria was revised to include the words, "superconductor," "high temperature," and "nitrogen" (as a high temperature superconductor typically uses liquid nitrogen to achieve the critical temperature) in all available text fields, "H01B 012" in the IPC class and "cable" in the Title field. This resulted in 152 patents found, with a maximum of 17 patents being assigned in 2006 and only two being assigned in 2015. The top assignee was Sumitomo Electric Industries, Ltd. The Patent Activity over time can be seen in Figure 22.

Figure 22. Superconductor, High Temperature, Nitrogen, H01B 012, Cable Search Criteria Results



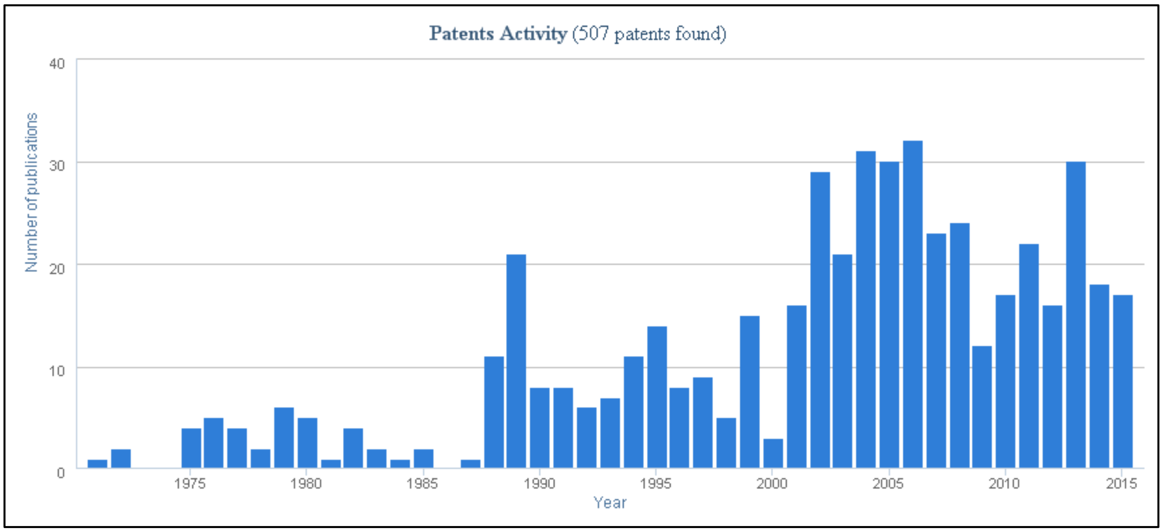
The additional filter of "HTS" was added to search in all available text fields and the results can be found in Figure 23.

Figure 23. Superconductor, High Temperature, Nitrogen, H01B 012, Cable, HTS Search Criteria Results



Reviewing the 53 resultant patents from this search, it would appear that nearly all were regarding the research topic at hand, but failed to include any developments prior to 2002. The search continued with the criteria “superconductor” in all available text fields, “H01B 012” in IPC Class and “cable” in the abstract, which provided the results in Figure 24.

Figure 24. Search Criteria Superconductor, H01B 12, and Cable

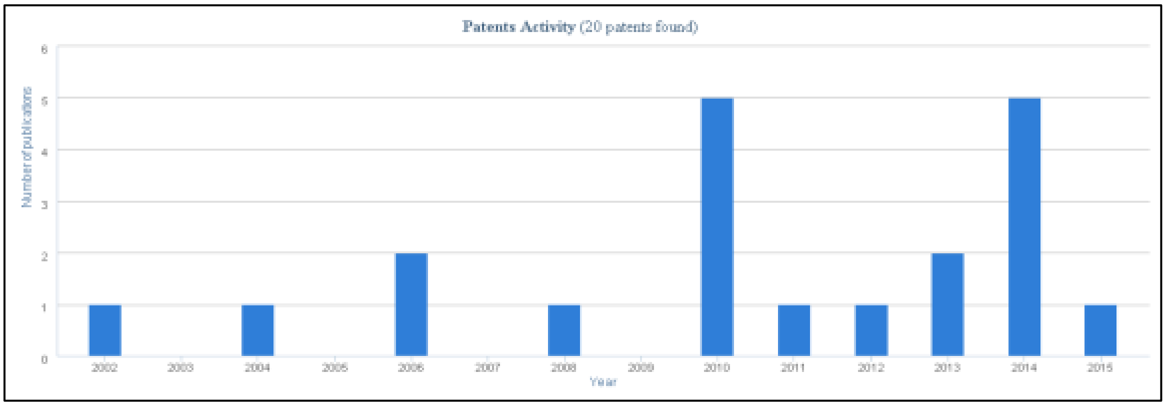


These results will be used for analysis and can be found in the Appendix.

2. High Temperature Superconducting Cooling

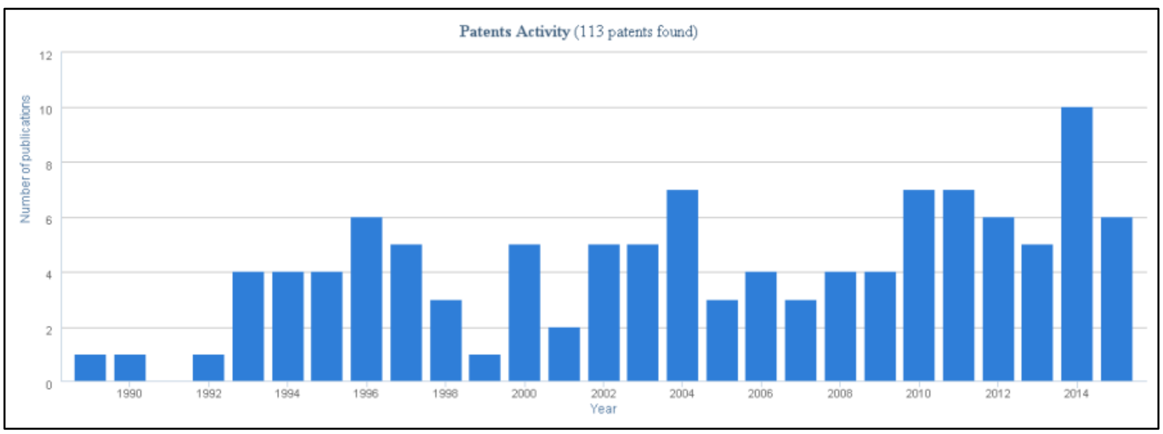
Based on the search process conducted for the HTS Cables, the research for cryogenic coolers began with the IPC code search criteria “H01B 12/16” which is the subset of H01B 12/00 and is ‘characterized by cooling’ and for “HTS” in all available text fields. This resulted in 20 patents shown over time in Figure 25.

Figure 25. Search Criteria HTS with IPC Code H01B 12/16



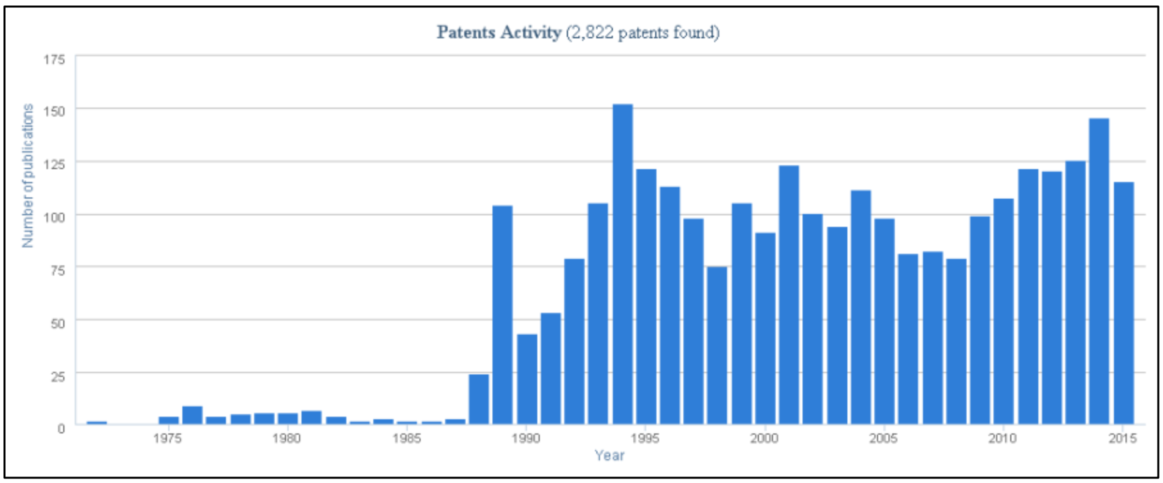
Of the 20 patents found, all appeared to be on the desired subject matter. In an effort to find any results which may have excluded the abbreviation "HTS" this criterion was replaced with "high temperature" with the results shown in Figure 26.

Figure 26. Search Criteria High Temperature with IPC Code H01B 12/16



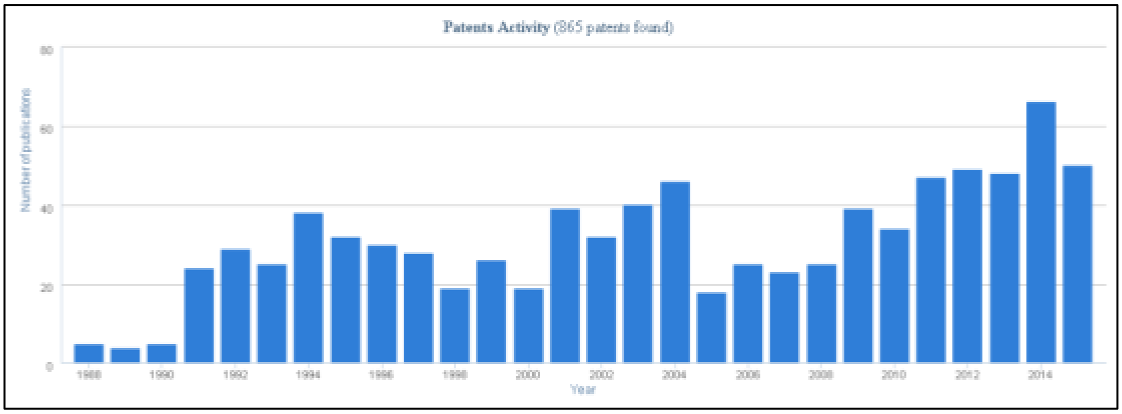
What is strikingly different with regards to these results and to those previously found for HTS Cables is that these results date back as far as 1989 while the HTS Cable results only go back to 2002. Furthermore, when searching the criteria “high temperature” in all available text fields and “H01B 12” in the IPC Class field, patents date as far back as 1972 and primarily focus on the cooling technology. This is due to the fact that cryogenic cooling technology predates high temperature superconductors. Looking at these results in Figure 27, it is plain to see that it took approximately two years from the discovery of high temperature superconductors in 1986 to cause a surge in patents relating to the findings.

Figure 27. Search Criteria High Temperature and H01B 12



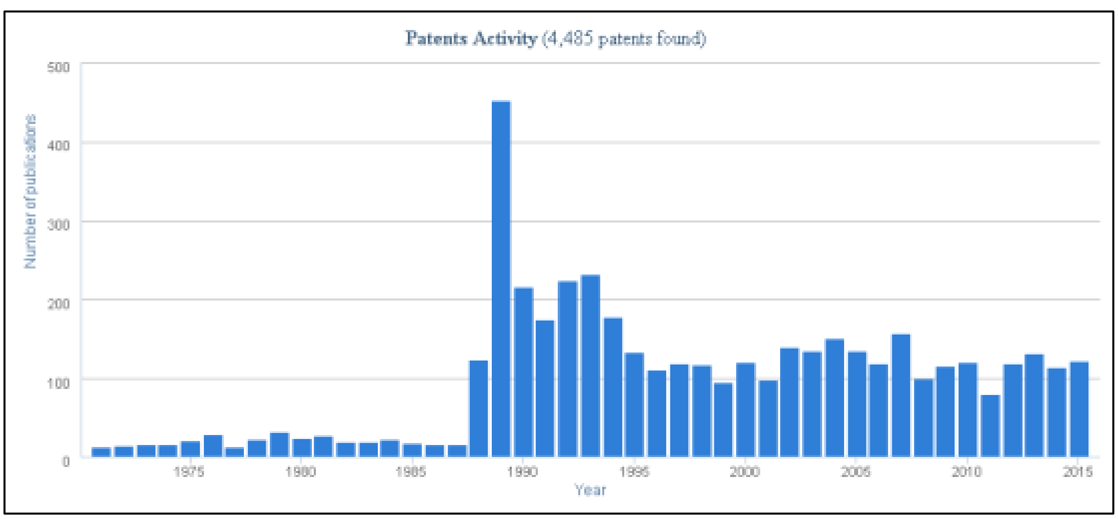
In fact, by adding the filter to include the criteria “yttrium” in all available search fields and searching from 1987 to 2015, the results of Figure 28 are obtained, showing a steady increase in patents starting in 1988 following the discovery of the YBCO superconducting compound.

Figure 28. Search Criteria High Temperature, H01B 12, Yttrium, from 1987 to 2015



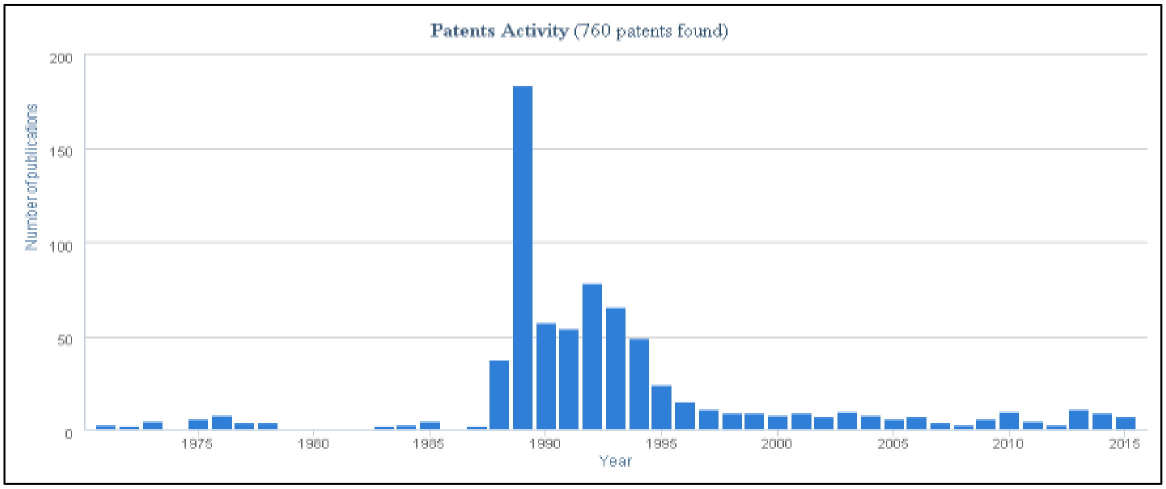
Of the results shown in Figure 28, 342 of the patents involved IPC Code H01B 013/00, the code for “Apparatus or processes specially adapted for manufacturing conductors or cables.” These results do not represent the desired sample of data since it involves too many patents due to the H01B 12 IPC code and potentially focuses unnecessarily on yttrium-based compounds, and thus will not be used. To expand the number of results, the terms “superconductor” in all available text fields and “cooling” in the abstract was used, which resulted in 4,485 patents found as shown in Figure 29.

Figure 29. Search Criteria Superconductor, Cooling



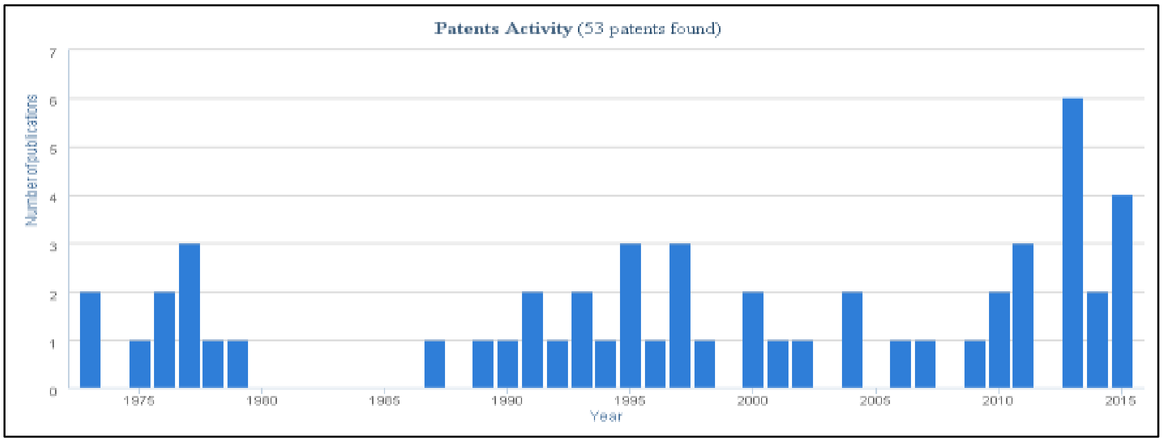
This large number of results is expected, as a review of the patent classes reveals that superconductor cooling refers to anything from compression machines or systems to superconducting magnets and coils. All of these results are relevant to a certain extent, as they all affect the innovations and developments of cooling a superconducting cable. In order to focus on the cables, though, the search term of "H01B 12" was added to the additional IPC classes search and the results are shown in Figure 30.

Figure 30. Search Criteria Superconductor, Cooling H01B 12



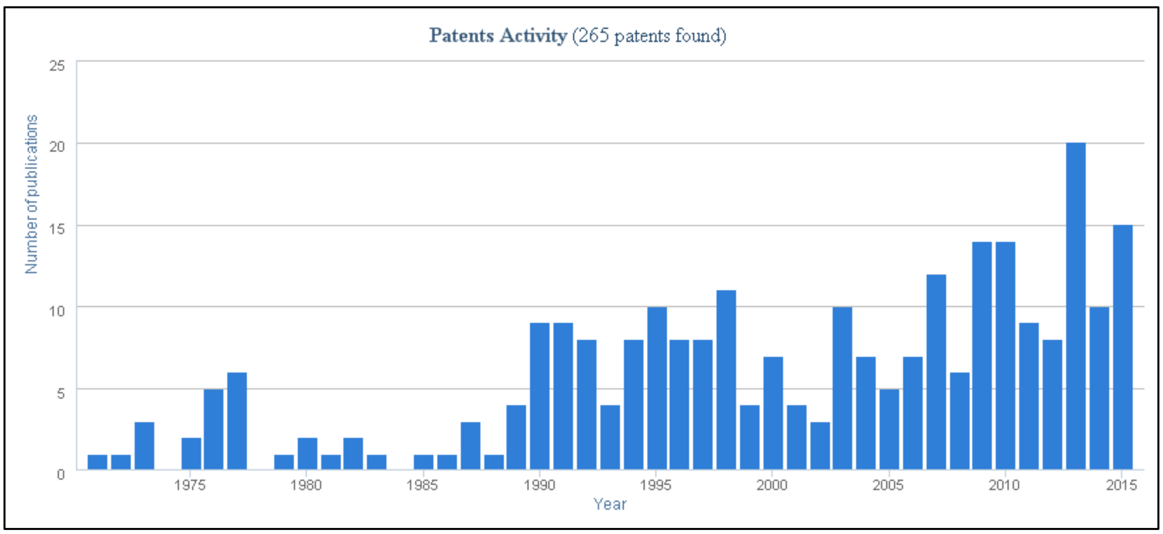
Reviewing this list of patents reveals that the large spike in patents in 1989 was due directly to the all of the patents related to manufacturing processes of yttrium-based superconducting materials and tapes. This clearly skews the trend toward the period following the discovery of the YBCO materials. To try to remove this bias, the criteria was refined to "superconductor" in all available text fields, "H01B" in additional IPC classes, and "cooling" in the title of the publication. The results are shown in Figure 31.

Figure 31. Search Criteria Superconductor, H01B, and Cooling



Based on these results the search criteria was modified to "superconductor" in all available text fields, "H01" in the IPC class, and "cooling" in the title. The patent activity is shown in Figure 32.

Figure 32. Search Criteria Superconductor, H01, Cooling



The table of the listed selected patents found in these results can be found in the Appendix.

IV. RESULTS AND REVIEW

The data collected was that of the number of relevant patents published by year in each of the categories of HTS Cables and HTS Cooling. The list of patents in each of their categories can be found in the Appendix.

A. FILTERING METHODS

The purpose of filtering is to refine the search results into a group of similar content to be reviewed. The primary methods of filtering include searching in

- "All available text fields"
- "Abstract"
- "Title"
- "IPC Class"
- "Additional IPC Classes"
- "Date"

The aim of the filtering was to find the patents that were specifically about HTS power cables and cryogenic coolers. Specific filtering terms were determined through trial and error, with an aim to include as many possible relevant patents while excluding those that are irrelevant. Through this trial and error, criteria and relevant classes were refined, reviewed, and retried to develop a better filter.

B. DATA COLLECTED

The raw data for the patents by year and by type is shown in Table 2.

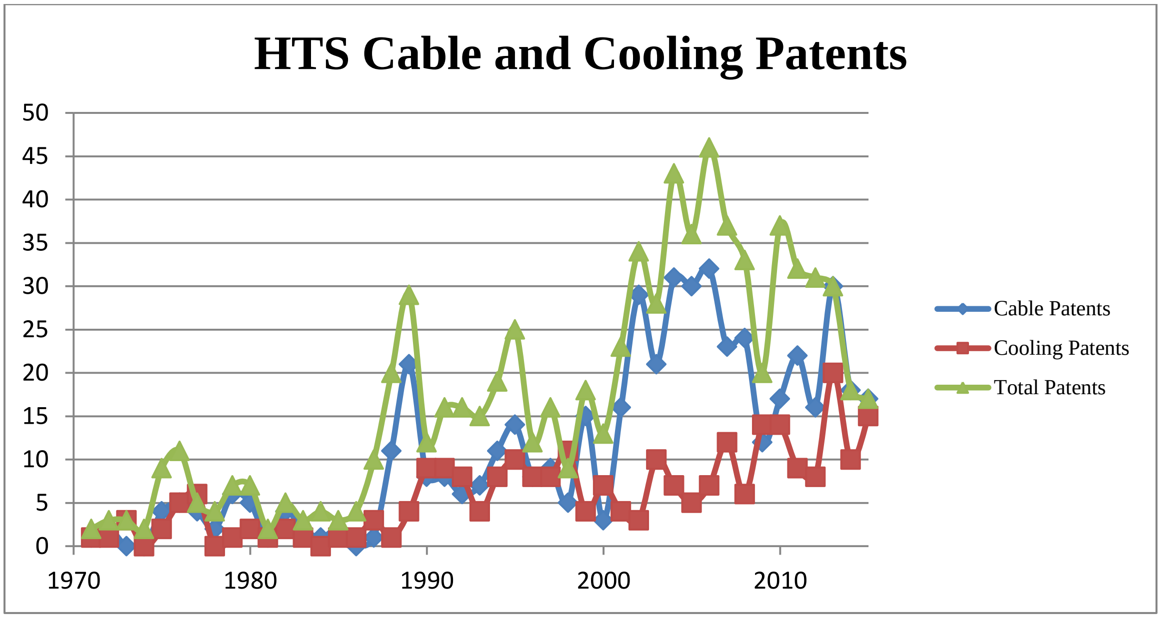
Table 2. Total Patent Types by Year

Cables		Cooling			Total
Year	**Cable Patents**	**Year**	**Cooling Patents**	**Year**	**Total Patents**
1971	1	1971	1	1971	2
1972	2	1972	1	1972	3
1973	0	1973	3	1973	3

Cables		Cooling			Total
Year	**Cable Patents**	**Year**	**Cooling Patents**	**Year**	**Total Patents**
1974	0	1974	0	1974	2
1975	4	1975	2	1975	9
1976	5	1976	5	1976	11
1977	4	1977	6	1977	5
1978	2	1978	0	1978	4
1979	6	1979	1	1979	7
1980	5	1980	2	1980	7
1981	1	1981	1	1981	2
1982	4	1982	2	1982	5
1983	2	1983	1	1983	3
1984	1	1984	0	1984	4
1985	2	1985	1	1985	3
1986	0	1986	1	1986	4
1987	1	1987	3	1987	10
1988	11	1988	1	1988	20
1989	21	1989	4	1989	29
1990	8	1990	9	1990	12
1991	8	1991	9	1991	16
1992	6	1992	8	1992	16
1993	7	1993	4	1993	15
1994	11	1994	8	1994	19
1995	14	1995	10	1995	25
1996	8	1996	8	1996	12
1997	9	1997	8	1997	16
1998	5	1998	11	1998	9
1999	15	1999	4	1999	18
2000	3	2000	7	2000	13
2001	16	2001	4	2001	23
2002	29	2002	3	2002	34
2003	21	2003	10	2003	28
2004	31	2004	7	2004	43
2005	30	2005	5	2005	36
2006	32	2006	7	2006	46
2007	23	2007	12	2007	37
2008	24	2008	6	2008	33
2009	12	2009	14	2009	20
2010	17	2010	14	2010	37
2011	22	2011	9	2011	32
2012	16	2012	8	2012	31
2013	30	2013	20	2013	30
2014	18	2014	10	2014	18
2015	17	2015	15	2015	17

The data collected and selected from the Search Criteria and was counted and plotted, by year, in Figure 33.

Figure 33. Combined Cable and Cooling Patents from 1970 to 2015



C. DATA ANALYSIS

A purely qualitative review of the trends indicates that surely the development in the field of superconductors was relatively stagnant prior to the discovery of the high temperature superconductors in 1986. Following that event, both the cooling and cable trends have been steadily increasing. There was also quite a serious increase from 2000 to 2002. This holds true with the results in Figure 15 and the events described in the History of Superconductivity, where during the decade starting in the 2000s many different HTS projects were being tested and evaluated, and presumably the results of that testing spawned additional patents and innovations.

1. Time Series Forecasting

A quantitative analysis was begun by performing a Time Series analysis on the each of the Cable and Cooling data series using the Risk Simulator add-in in Microsoft

Excel. Performing this regression and projecting forward five additional years yields the results shown in Figures 34, 35, and 36.

Figure 34. Time Series Analysis of Cable Patents Over Time

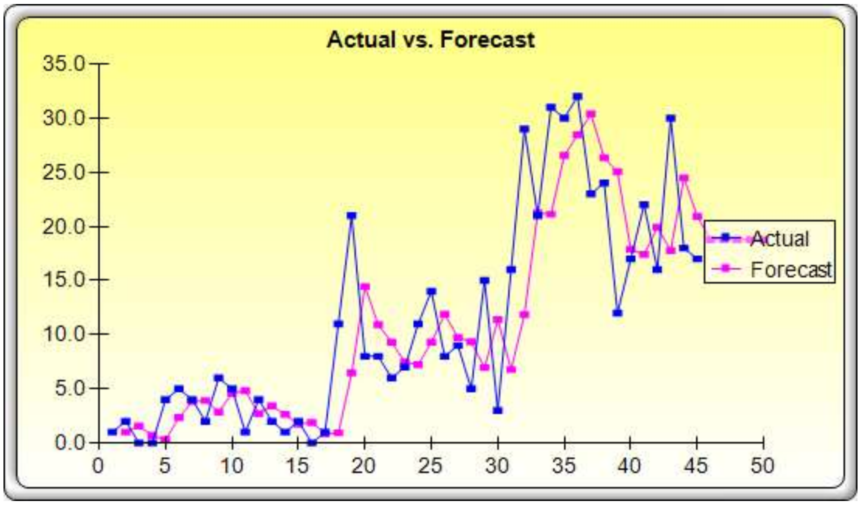


Figure 35. Time Series Analysis of Cooling Patents Over Time

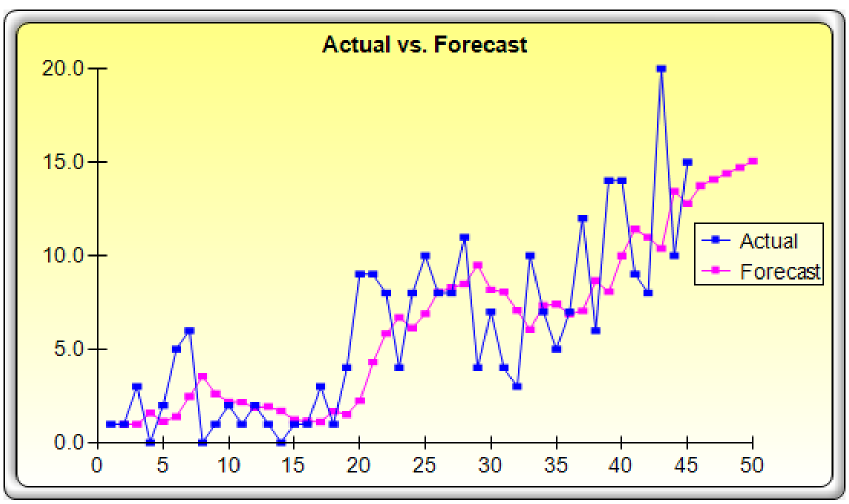
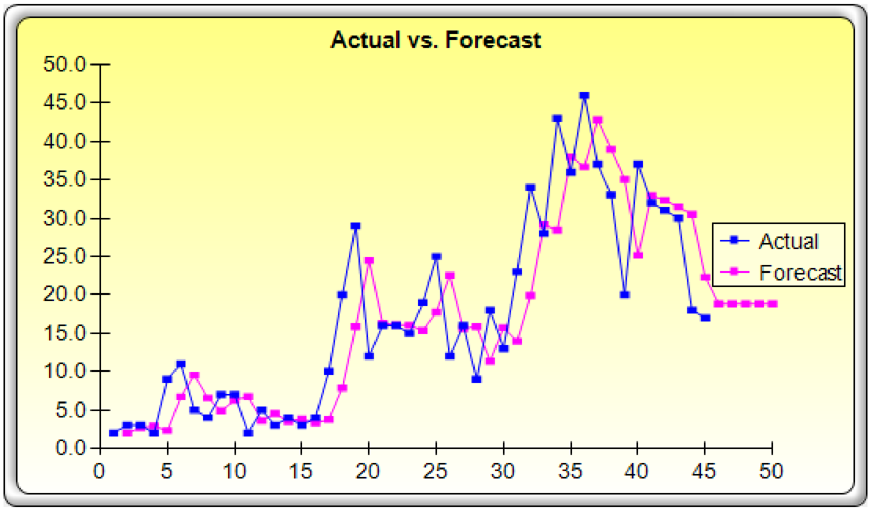


Figure 36. Time Series Analysis of Combined Patents Over Time

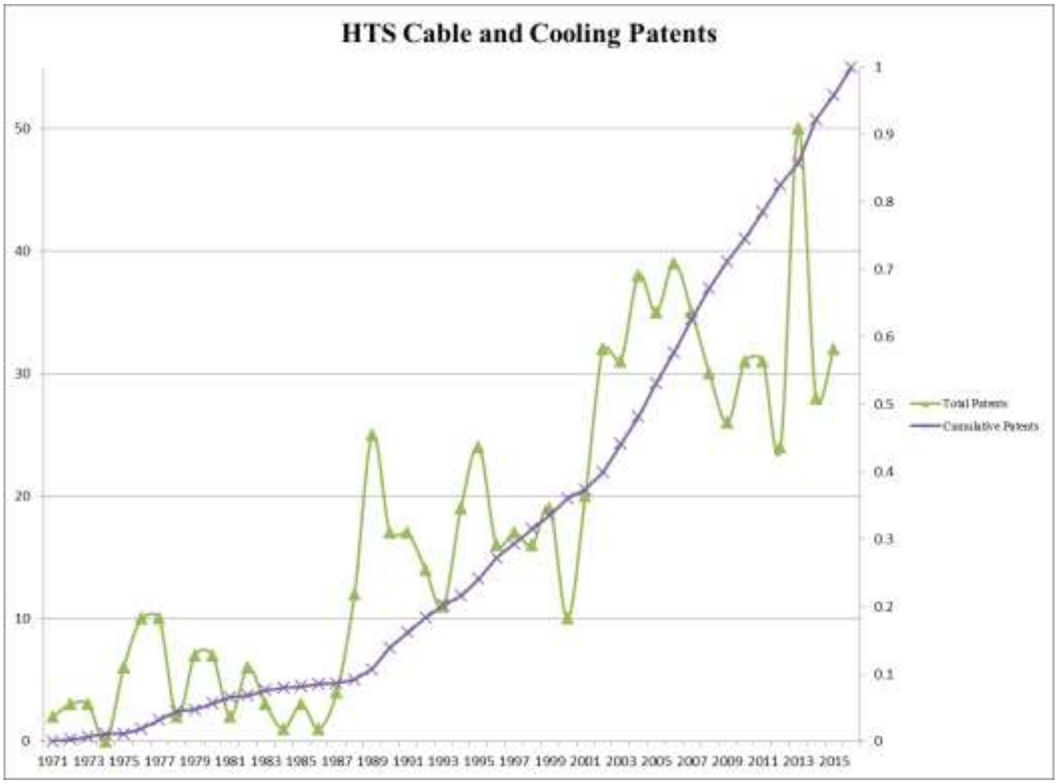


As shown in each of the graphs, the forecasts predict only a linear projection, which does not provide an accurate interpretation of the data trends overall. Specifically, the Cable Patents forecast was conducted using a Seasonal Additive regression with Alpha of 0.0987 and Gamma of 0.5000; the Cooling Patents forecast was conducted using a Holt-Winter's Multiplicative regression with Alpha of 0.0048, Beta of 1.0000 and Gamma of 0.2802 and 1 season; the Combined Patents also used a Seasonal Multiplicative regression with an Alpha of 0.3149, Gamma of 0.5000, and 1 season.

2. Cumulative Data Plots

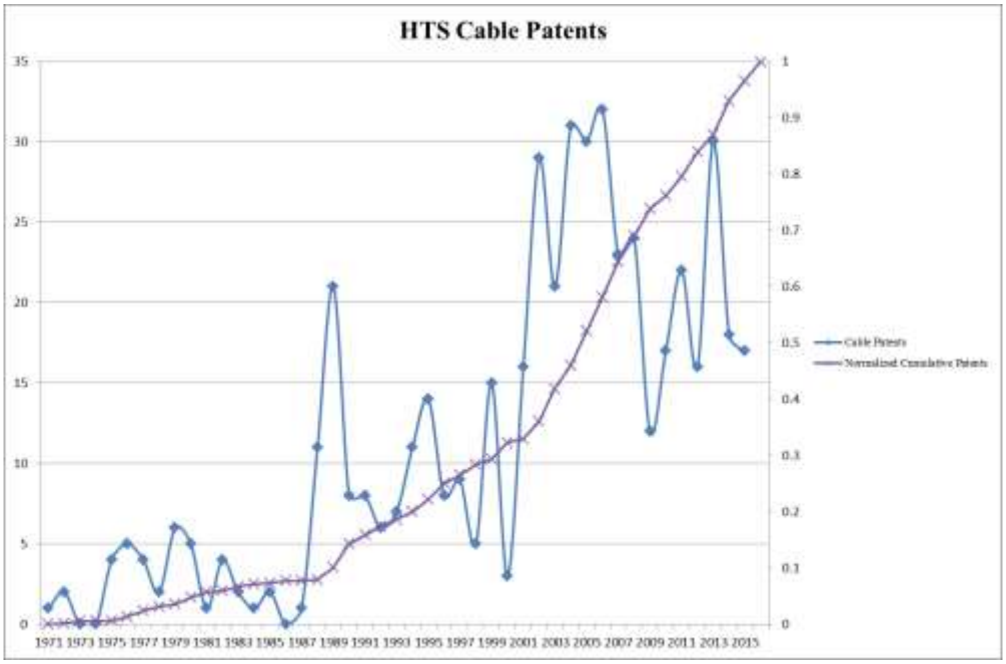
The normalized cumulative total patents were also plotted over time. This was done to demonstrate the growth in the number of patents using a simple display and allows for a simple qualitative evaluation based on the slope of the line. A more vertical line indicates an increase in patents, while a more horizontal line indicates stagnation in the field. The cumulative plot is shown, superimposed over the patent activity over time plots from before, in Figure 37.

Figure 37. Cumulative Plot of Total Selected HTS Patents Over Time



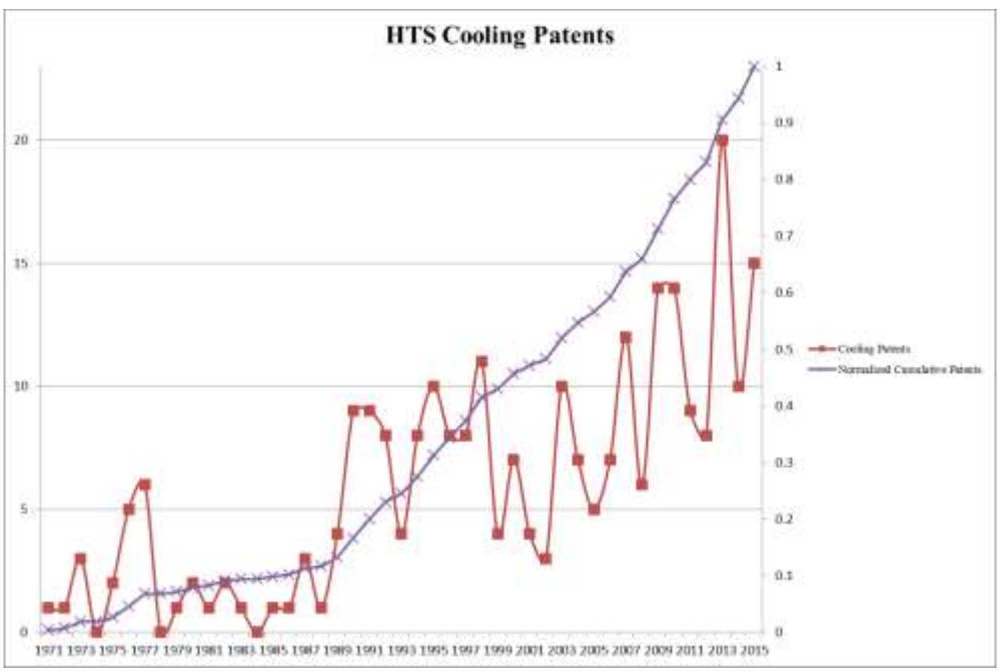
The cumulative plot in Figure 37 shows the growth of the patent base over the last 29 years since the discovery of HTS. The trends shown by the slope of the cumulative line are greatest since the year 2000. Observing the same cumulative patents over each of the individual sources, the Cables and the Cooling, in Figure 38 and Figure 39 show the same trends.

Figure 38. Cumulative Plot of Selected Cable Patents Over Time



The HTS Cable Patents over time and their cumulative plot counterpart are shown, indicating a surge in patent publications starting in 2001 but then slowing down in 2009.

Figure 39. Cumulative Plot of Selected Cooling Patents Over Time



The HTS Cooling Patents over time and their cumulative plot counterpart are shown, indicating a gradual increase in slope beginning in the year 2001 and continuing until 2015.

To a varying degree of similarity, all three of the plots shown have a linear, positive slope, which would indicate an increase in development of the technology. The cable patents, though, do show some signs of slowing down since 2009 relative to the previous eight years.

At some point in the future it would be expected that the increase in patents would begin to decline. Once this were to occur, the slopes of the cumulative lines would begin to level-off and become more horizontal, indicating that the innovation of the technology would become stagnant. It is difficult, at best, to determine the future duration of the linear rise of cumulative patents and thus impossible to predict when it will begin to level off and stagnate.

Notably and significantly, all of the trends are positive and increasing. It is difficult, at best, to determine which of the two factors, if either is driving the advances in the other. As previously noted, there are many other categories in the field of superconductivity that are not being considered in this research that may be driving the advancements. Whatever it is that may be the primary driver of the innovation in the field, the one specific incident that was most cause for excitement was the discovery of the high temperature superconductors in 1986.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS OF STUDY

HTS power transmission innovation through the use of HTS cables and their necessary cooling systems is on the rise. Since its discovery in 1986 the technology has been growing and maturing, and as of 2015, there is no indication of this trend ending in the near term as patent activity over time shows a linear, positive slope which would indicate a projected continuing increase in development of the technology. The cable patents, though, do show some signs of slowing down since 2009 relative to the previous eight years. At some point in the future it would be expected that the increase in patents would begin to decline. Once this were to occur, the slopes of the actual patent activity curves would begin to level-off and become more asymptotic, indicating that the innovation of the technology would become stagnant. It is difficult, at best, to determine the future duration of the linear rise of cumulative patents and thus impossible to predict when it will begin to level off and stagnate. Studies should then proceed to find out where the technology innovations might be shifting, to other areas for example that might be replacing the technology base that provided the current trend basis. Conversely, though, there is no indicator of the extent to which the innovation can continue. Just as with its sudden and surprise discovery, there is no telling where this innovation will go to next. But with the significant number of patents found that were in the class of manufacturing processes, it would seem that industry is preparing to increase supply to meet an increase in the demand of the technology. This demand comes in part from the U.S. Navy and its development in high energy weapons and the electric ship.

The IHS Goldfire Cloud Connect software was a valuable tool to use in this research. While unaware of any similar software, this one met more than what was required to conduct this research and provided many capabilities that could and should be used in future projects. Many of the functions that the software provided were not used in this research, but may be useful in others.

B. REVIEW OF METHODOLOGY

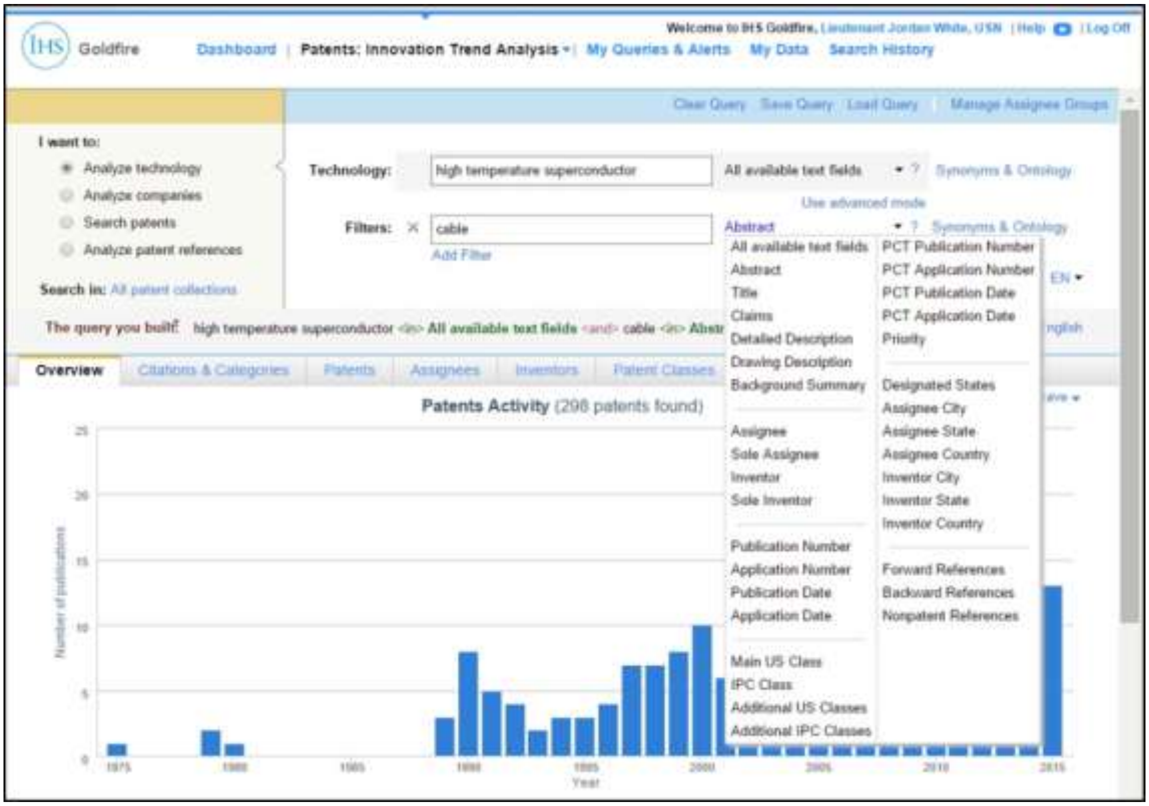
1. Search Criteria Review

The process of selecting the appropriate search criteria was primarily a “trial and error” approach. Given the long, tedious process with multiple dead-ends and paths that lead to unnecessary results, a lot of time was spent on developing the appropriate terms that could have been better spent on reviewing results. A greater understanding of the patent publication process and organization would have alleviated some of the stresses of determining how to find the desired patents without the undesirable. The process was, however, very enlightening in the aspects of patent infrastructure and organization, though this was not the focus of the research.

2. Software Review

The IHS Goldfire search software is a powerful tool to use but with its complexity comes the potential for errors and glitches. One such recurring glitch was that of IHS Goldfire’s selection/menu tabs, as shown in Figure 40.

Figure 40. IHS Goldfire's Selection/Menu Tab Glitch

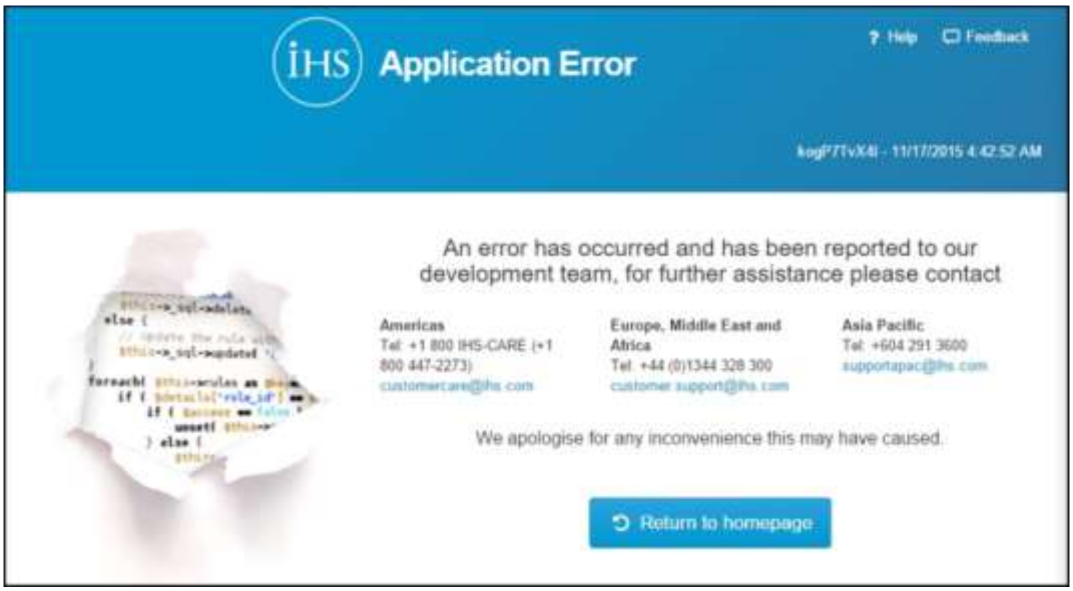


This problem occurs when the user clicks on one of the field selection arrows (in this case, the downward pointing arrow near the "Abstract" filter). When the new menu appears, the user must click on one of the possible filter titles that are listed on the menu. There is no other way to cause the menu to disappear after causing it to pop up. This is not particularly intuitive and can cause some annoyance.

Another concern is that it appears that the software occasionally times-out unexpectedly. While working on search results that have opened in another browser window, when returning to the main search page it will display the "user has been logged off due to inactivity" after as little as ten minutes. In other circumstances, the same would happen after a more reasonable thirty minutes. There is no information on this subject in the Help section nor is there any sort of method for adjusting this option in the User Profile or Preferences settings.

Occasionally while working on a home wireless Internet connection, and without warning, a result will be found at one of the IHS content sources (Jane's Information Group, for example) that will result in an Application Error page like shown in Figure 41. It is unknown as to the cause of these errors, but they also occur while on the NPS virtual private network (VPN) on a home Internet connection. Such errors also occur while connected to the NPS wireless network.

Figure 41. Application Error Page



It must also be stated that each of the issues and glitches described have been documented and forwarded via email to the IHS Customer Care email who responded to the issues within approximately 24 hours. All concerns will be provided to the IHS Goldfire development team for review and possible implementation.

Toward the end of this research the Goldfire software was updated from version 10.2 to version 10.3 and the issues and glitches described were all corrected and resolved. There was no specific notification from the IHS Customer Care in regards to the fact that the software was updated with the exception of the announcement on the IHS Goldfire Dashboard IHS Goldfire News feed.

C. POTENTIAL IMPACTS ON SHIP DESIGN AND THE U.S. NAVY

The successful testing of the HTS degaussing system on a U.S. Navy ship at sea showed the feasibility of installing and operating HTS equipment onboard a ship. In the same way that the electric lights were installed on *USS Trenton* in 1883 with moderate popularity resulted eventually in electric-powered ships, the testing of the HTS degaussing system could serve as a similar framework. With the technology continuing to grow, develop, and innovate as shown, there is significant applicability for the U.S. Navy. It would be highly recommended that the U.S. Navy continue its investment in the HTS technology field to remain at the leading edge of its innovation.

HTS cables could be used by the U.S. Navy initially in non-critical systems, such as done with the degaussing system. They could then be used as a redundant alternative to conventional conducting cables between generators and switchboards, or from generators to electric drive motors. As systems became more reliable and durable, HTS redundancies can be put in place and provide power transmission to conventional and high-powered weapons, too. But HTS is not without its burdens, as the addition of the cables will require additional space for cryogenic cooling and power for those systems, though it could be possible in the future to combine cryogenic cooling systems as part of traditional air conditioning plants installed on ships.

D. RECOMMENDATIONS FOR FUTURE WORK

A major consideration that warrants significant research is that of cryogenic coolers for use in superconducting cable applications. While the high temperature superconductor discovery in 1986 was a game-changer in the field, and has spurred an increase in research and innovations, all of these still require an efficient and effective cryogenic cooler. Any additional research surrounding cryogenic coolers would be beneficial and could advance the installation of HTS transmission cables on naval ships. The possibility of combining a cryogenic cooler with a traditional air conditioning system on ships that provide cold air for weapons systems could increase the effectiveness and efficiency of them both. This would be worthwhile research to perform.

Another potential project would be to predict or project the cost of HTS materials and associated equipment and how that would affect the cost of ships. Likewise, it would be beneficial to examine how the increased demand of HTS transmission cables by the U.S. Navy would affect the supply and cost.

High-energy-density and high-power-density HTS components that specifically support the projected requirements for power and energy needed for future electric weapons could also be investigated to determine the potential of HTS technologies for direct-charging a rail gun, or for interfacing a rail gun to its electric magazine, for example. Feasibility of any sort of cooling for such a system could also be examined.

APPENDIX. COLLECTED DATA

The complete listing of the patents considered during this research is found below.

Query: superconductor <in> All available text fields <and> H01 <in> IPC Class <and> cooling <in> Title
Table Name Patents

Publication Number	Assignee	Publication Date	Title	Main IPC Class
US-20150332829 A1	General Electric Company (United States, Schenectady, NY)	11/19/2015	CRYOGENIC COOLING SYSTEM	H01F 006/04
EP-2945199 A1	Furukawa Electric Co., Ltd. (Japan, Chiyoda-ku Tokyo 100–8322)	11/18/2015	SUPERCONDUCTING FAULT CURRENT LIMITER AND COOLING METHOD FOR SUPERCONDUCTING ELEMENT WITHIN SUPERCONDUCTING FAULT CURRENT LIMITER	H01L 039/16
US-20150325338 A1	American Superconductor Corporation (United States, Devens, MA)	11/12/2015	ELECTRICITY TRANSMISSION COOLING SYSTEM	H01B 012/16
EP-2286487 B1	Rolls-Royce plc (United Kingdom, London SW1E 6AT)	11/11/2015	A COOLING ARRANGEMENT FOR AN ELECTRICAL CONNECTOR FOR A SUPERCONDUCTOR	H01R 004/68
JP-05809391 B2	ゼネラル・エレクトリック・カンパニイ	11/10/2015	Device of superconducting magnet cooling and method	H01F 006/04
US-20150228391 A1	Hitachi, Ltd., (Japan, Tokyo)	8/13/2015	CONDUCTIVE COOLING-TYPE PERSISTENT CURRENT SWITCH, MRI APPARATUS AND NMR APPARATUS	H01F 006/06
WO-2015120113 A1	WEINBERG MEDICAL PHYSICS LLC (United States)	8/13/2015	ELECTROMAGNETIC DEVICES WITH INTEGRATED COOLING	H01K 001/20
WO-2015109508 A1	ABB TECHNOLOGY LTD (Switzerland), ZHUANG, Genhuang (China), DUKKAIAPPAN, Subbiah Thevar (Italy), ZHANG, Yan (China), QUE, Yinzhong (China)	7/30/2015	COOLING DEVICE FOR A GAS INSULATED SWITCHGEAR	H01H 009/52
US-20150145624 A1	WEINBERG MEDICAL PHYSICS LLC (United States, Bethesda, MD)	5/28/2015	ELECTROMAGNETIC MOTOR AND OTHER ELECTROMAGNETIC DEVICES WITH INTEGRATED COOLING	H01F 027/10
US-9037202 B2	American Superconductor Corporation (United States, Devens, MA)	5/19/2015	Electricity transmission cooling system	H01L 039/00
WO-2015069331 A1	PICKRELL, Gary R. (United States), HOMA, Daniel S. (United States)	5/14/2015	SUPERCONDUCTING FIBER AND EFFICIENT CRYOGENIC COOLING	H01B 012/02
US-9000295 B1	The Florida State University Research Foundation, Inc. (United States, Tallahassee, FL)	4/7/2015	Termination for gas cooled cryogenic power cables	H01B 017/54
US-20150015260 A1	Samsung Electronics Co., Ltd. (Republic of Korea, Gyeonggi-do)	1/15/2015	COOLING SYSTEM AND SUPERCONDUCTING MAGNET APPARATUS EMPLOYING THE SAME	H01F 006/04
DE-102013213242 A1	Siemens Aktiengesellschaft (Germany(3), München)	1/8/2015	Coil device with coil and cooling device as well as method for the cooling of a coil	H01F 006/04
US-20150007587 A1	Siemens Aktiengesellschaft (Germany, Munich)	1/8/2015	DEVICE FOR COOLING A SUPERCONDUCTING MACHINE	H01F 006/04
US-20140378312 A1	Railway Technical Research Institute (Japan, Tokyo)	12/25/2014	SUPERCONDUCTING CABLE, AND DEVICE AND METHOD FOR COOLING SUPERCONDUCTING CABLE	H01B 012/16
EP-2797132 A1	Japan Oil, Gas and Metals National Corporation (Japan, Tokyo 105–0001), International Superconductivity Technology Center (Japan, Kawasaki-shi, Kanagawa 213–0012)	10/29/2014	LIQUID NITROGEN COOLING SENSOR DEVICE CONTAINER AND LIQUID NITROGEN COOLING SENSOR DEVICE	H01L 039/04
EP-2793240 A1	Mayekawa Mfg. Co., Ltd. (Japan, Koto-ku Tokyo 135–8482), Railway Technical Research Institute (Japan, Kokubunji-shi, Tokyo 185–8540)	10/22/2014	SUPERCONDUCTING CABLE, AND DEVICE AND METHOD FOR COOLING SUPERCONDUCTING CABLE	H01B 012/16
GB-2469176	GEN ELECTRIC (United States of	10/1/2014	Apparatus for superconducting magnet cooling	H01F 006/04

Publication Number	Assignee	Publication Date	Title	Main IPC Class
B	America)			
US-8841980 B2	ASG Superconductors S.p.A. (Italy, Genoa)	9/23/2014	Coil with superconductive windings cooled without cryogenic fluids	H01F 001/00
JP-05532113 B2	パナソニック株式会社	6/25/2014	Electronics provided with cooling system and it	H01L 023/427
US-20140162882 A1	The Florida State University Research Foundation, Inc. (United States, Tallahassee, FL)	6/12/2014	CABLE TERMINATION FOR HIGH VOLTAGE POWER CABLES COOLED BY A GASEOUS CRYOGEN	H01B 012/16
GB-2504144 A	Siemens plc (United Kingdom)	1/22/2014	Superconducting joint in combination with a cooling surface	H01R 004/68
US-20140011684 A1	JETTER, NEIL ROBERT (United States, Palm Beach Gardens, FL)	1/9/2014	SUPERCONDUCTOR TRANSMISSION LINES HAVING JOINT LN2 AND THERMOELECTRIC COOLING	H01B 012/16
DE-102012210802 A1	Siemens Aktiengesellschaft (Germany(3), München)	1/2/2014	Coil arrangement and method for the production as well as use of the coil arrangement with cooling	H01F 027/10
JP-05374116 B2	三菱重工業株式会社	12/25/2013	Superconductor cooling system and superconductor cooling method	H01L 039/04
US-20130333912 A1	Mayekawa Mfg. Co., Ltd. (Japan, Tokyo)	12/19/2013	SUPERCONDUCTING CABLE COOLING SYSTEM	H01B 012/16
WO-2013177678 A1	THE ROYAL INSTITUTION FOR THE ADVANCEMENT OF LEARNING/McGILL UNIVERSITY (Canada)	12/5/2013	METHOD AND SYSTEM FOR MAGNETIC SEMICONDUCTOR SOLID STATE COOLING	H01L 023/34
JP-2013219195 A	CHUBU ELECTRIC POWER CO INC	10/24/2013	CONDUCTION COOLING PLATE OF SUPERCONDUCTING COIL AND SUPERCONDUCTING COIL DEVICE	H01F 006/04
JP-2013534701 A	シーメンス ピーエルシー	9/5/2013	Cooling method of superconducting joint cup and superconducting joint	H01R 004/68
JP-05253507 B2	コメット アクチェンゲゼルシャフト	7/31/2013	Cooling system for variable capacity vacuum condenser	H01G 005/013
JP-05228177 B2	スーパーパワー インコーポレイテッド	7/3/2013	Cryogenic temperature cooling method for high-temperature superconductor device and device	H01L 039/04
US-20130165325 A1	Frank, Michael (Germany, Uttenreuth), Van Hasselt, Peter (Germany, Erlangen)	6/27/2013	APPARATUS AND METHOD FOR COOLING A SUPER CONDUCTING MACHINE	H01L 039/02
JP-2013125647 A	株式会社前川製作所 公益財団法人鉄道総合技術研究所	6/24/2013	Cooling system of superconducting cable and superconducting cable and cooling method	H01B 012/16
JP-2013125647 A	MAYEKAWA MFG CO LTD, Railway Technical Research Institute	6/24/2013	SUPERCONDUCTING CABLE, AND DEVICE AND METHOD FOR COOLING THE SAME	H01B 012/16
WO-2013089219 A1	Mayekawa Mfg. Co., Ltd. (Japan), Railway Technical Research Institute (Japan)	6/20/2013	超電導ケーブル、並びに超電導ケーブルの冷却装置及び冷却方法	H01B 012/16
WO-2013085181 A1	Korea Basic Science Institute (Republic of Korea)	6/13/2013	COOLING SYSTEM FOR SUPERCONDUCTIVE MAGNETS	H01F 006/04
JP-2013074082 A	ジャパンスーパーコンダクタテクノロジー株式会社	4/22/2013	Conduction cooling type superconducting magnet device providing permanent current switch and it	H01L 039/16
JP-2013074082 A	JAPAN SUPERCONDUCTOR TECHNOLOGY INC	4/22/2013	PERMANENT-CURRENT SWITCH, AND CONDUCTIVE COOLING-TYPE SUPERCONDUCTING MAGNET DEVICE HAVING THE SAME	H01L 039/16
US-20130090242 A1	Varian Semiconductor Equipment Associates, Inc. (United States, Gloucester, MA)	4/11/2013	Techniques for Sub-Cooling in a Superconducting System	H01L 039/02
JP-2013065659 A	JAPAN SUPERCONDUCTOR TECHNOLOGY INC	4/11/2013	CONDUCTION COOLING TYPE SUPERCONDUCTIVE MAGNET DEVICE	H01F 006/00
JP-2013055355 A	パナソニック株式会社	3/21/2013	Electronics provided with cooling system and it	H01L 023/427
US-20130065766 A1	American Superconductor Corporation (United States, Devens, MA)	3/14/2013	ELECTRICITY TRANSMISSION COOLING SYSTEM	H01B 012/16
JP-05151362 B2	パナソニック株式会社	2/27/2013	Electronics provided with cooling system and it	H01L 023/427
US-8352002 B2	Mitsubishi Heavy Industries, Ltd. (Japan, Tokyo)	1/8/2013	Superconductor cooling system and superconductor cooling method	H01L 039/02
US-		10/4/2012	LOW-NOISE COOLING APPARATUS	H01F 006/04

Publication Number	Assignee	Publication Date	Title	Main IPC Class
20120252678 A1				
US-8280467 B2	American Superconductor Corporation (United States, Devens, MA)	10/2/2012	Electricity transmission cooling system	H01B 012/16
US-8253024 B2	Siemens plc (United Kingdom, Frimley, Camberley)	8/28/2012	Method and apparatus for cooling superconductive joints	H01B 012/00
JP-04977451 B2	ゼネラル・エレクトリック・カンパニイ	7/18/2012	Cold mass accompanying the coupler of superconducting magnet and discrete route and in substance conductivity for refrigerant cooling circuit	H01F 006/00
EP-2183753 B1	Tesla Engineering Limited (United Kingdom, Storrington West Sussex RH20 3EA)	5/16/2012	COOLING METHODS	H01F 006/04
US-20120094840 A1		4/19/2012	REFRIGERATOR COOLING-TYPE SUPERCONDUCTING MAGNET	H01F 006/06
EP-2439754 A1	Hitachi, Ltd. (Japan, Chiyoda-ku Tokyo 100–8280)	4/11/2012	REFRIGERATOR COOLING-TYPE SUPERCONDUCTING MAGNET	H01F 006/04
JP-04903729 B2	新日本製鐵株式会社	3/28/2012	Oxide superconducting magnet and that manufacturing method and cooling method	H01F 006/04
JP-04799979 B2	新日本製鐵株式会社	10/26/2011	Cooling method of magnetic method of manufacturing method of oxide superconductor coil, oxide superconductor coil, oxide superconductor coil, oxide superconductor coil and magnet system	H01F 006/06
JP-04797000 B2	独立行政法人理化学研究所, 独立行政法人情報通信研究機構, 三井金属鉱業株式会社, 住友重機械工業株式会社, 株式会社日本計器製作所, 太田 浩	10/19/2011	Cooling system for high temperature superconducting magnetic shield body	H01L 039/04
US-8022798 B2	ASG Superconductors S.p.A (Italy, Genoa)	9/20/2011	Coil with superconductive windings cooled without cryogenic fluids	H01F 006/00
GB-2467595 B	Tesla Engineering Limited (United Kingdom)	8/24/2011	Cooling systems and methods	H01F 006/04
GB-2451708 B	Tesla Engineering Limited (United Kingdom)	7/13/2011	Cooling methods	H01F 006/04
JP-2011091212 A	JAPAN SUPERCONDUCTOR TECHNOLOGY INC	5/6/2011	SUPERCONDUCTING MAGNET DEVICE AND INITIAL COOLING METHOD FOR SUPERCONDUCTING COIL OF THE SAME	H01F 006/04
JP-2011082343 A	FUJI ELECTRIC SYSTEMS CO LTD	4/21/2011	COOLING APPARATUS FOR SUPERCONDUCTION EQUIPMENT	H01L 039/04
DE-102009038308 A1	Siemens Aktiengesellschaft, 80333 München, DE	2/24/2011	Method for the operation of a refrigerating apparatus for cooling of a superconductor as well as for it suitable refrigerating apparatus	H01F 006/04
US-20110045988 A1	KARLSRUHER INSTITUT FUER TECHNOLOGIE (Germany, Karlsruhe)	2/24/2011	HIGH-TEMPERATURE SUPERCONDUCTING RIBBON CONDUCTOR COMPOSITE PROVIDED WITH A COOLING LAYER	H01B 012/00
EP-2075805 B1	ASG Superconductors S.p.A. (Italy, 16153 Genova)	12/22/2010	A coil having superconducting windings cooled without cryogenic fluids	H01F 006/04
JP-2010539677 A	コメット アクチェンゲゼルシャフト	12/16/2010	Cooling system for variable capacity vacuum condenser	H01G 005/013
JP-2010245524 A	ゼネラル・エレクトリック・カンパニイ	10/28/2010	Device and method for cooling the superconducting magnet assembly	H01F 006/04
JP-2010245523 A	ゼネラル・エレクトリック・カンパニイ	10/28/2010	Device of superconducting magnet cooling and method	H01F 006/04
GB-2469717 A	General Electric Company (United States of America)	10/27/2010	Apparatus and method for cooling a superconducting magnetic assembly	H01F 006/04
US-20100267567 A1	Koninklijke Philips Electronics N.V. (Netherlands, Eindhoven)	10/21/2010	SUPERCONDUCTING MAGNET SYSTEM WITH COOLING SYSTEM	H01F 006/04
GB-2469176 A	General Electric Company (United States of America)	10/6/2010	Apparatus and method of superconducting magnet cooling using a pulsating heat pipe	H01F 006/04
GB-2467595 A	Tesla Engineering Limited (United Kingdom)	8/11/2010	Cooling systems and methods for one or more superconducting coils	H01F 006/04
JP-2010109187 A	三菱重工業株式会社	5/13/2010	Superconductor cooling system and superconductor cooling method	H01L 039/04
JP-2010109187	MITSUBISHI HEAVY IND LTD	5/13/2010	SYSTEM AND METHOD FOR COOLING SUPERCONDUCTOR	H01L 039/04

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A				
US-20100113282 A1	Mitsubishi Heavy Industries, Ltd. (Japan, Tokyo)	5/6/2010	SUPERCONDUCTOR COOLING SYSTEM AND SUPERCONDUCTOR COOLING METHOD	H01L 039/02
US-20100087322 A1		4/8/2010	ELECTRICITY TRANSMISSION COOLING SYSTEM	H01L 039/02
WO-2010039513 A1	YUAN, Jie (United States), American Superconductor Corporation (United States), MAGUIRE, James (United States)	4/8/2010	ELECTRICITY TRANSMISSION COOLING SYSTEM	H01B 012/16
GB-2432898 B	GEN ELECTRIC (United States of America)	3/31/2010	Cold mass cryogenic cooling circuit inlet path avoidance of direct conductive thermal engagement with substantially conductive coupler for superconducting	H01F 006/04
US-20090315655 A1	ASG Superconductors S.p.A. (Italy, Genova)	12/24/2009	COIL WITH SUPERCONDUCTIVE WINDINGS COOLED WITHOUT CRYOGENIC FLUIDS	H01F 006/04
WO-2009150398 A1	Rolls-Royce plc (United Kingdom), HUSBAND, Stephen, Mark (United Kingdom), SMITH, Alexander, Charles (United Kingdom), HARRISON, Stephen, Mark (United Kingdom)	12/17/2009	A COOLING ARRANGEMENT FOR AN ELECTRICAL CONNECTOR FOR A SUPERCONDUCTOR	H01R 004/68
US-7626477 B2	General Electric Company (United States, Niskayuna, NY)	12/1/2009	Cold mass cryogenic cooling circuit inlet path avoidance of direct conductive thermal engagement with substantially conductive coupler for superconducting magnet	H01F 001/00
GB-2432725 B	General Electric Company (United States of America)	10/21/2009	Cold mass with discrete path substantially conductive coupler for superconducting magnet and cryogenic cooling circuit	H01F 006/04
JP-2009529239 A	リンデ・インコーポレーテッド	8/13/2009	Multi tank device and method for cooling the superconductor	H01L 039/04
JP-2009170550 A	NIPPON STEEL CORP	7/30/2009	Oxide superconducting magnet and that manufacturing method and cooling method	H01F 006/04
JP-2009170550 A	NIPPON STEEL CORP	7/30/2009	OXIDE SUPERCONDUCTING MAGNET, ITS MANUFACTURING METHOD, AND COOLING METHOD	H01F 006/04
US-7567160 B2	American Superconductor Corporation (United States, Westborough, MA)	7/28/2009	Supplementary transformer cooling in a reactive power compensation system	H01F 027/08
US-7559205 B2	Siemens Magnet Technology Ltd. (United Kingdom, Witney)	7/14/2009	Cryogen tank for cooling equipment	H01F 006/00
EP-2075805 A1	ASG Superconductors S.p.A. (Italy, 16153 Genova)	7/1/2009	A coil having superconducting windings cooled without cryogenic fluids	H01F 006/04
JP-2009088125 A	PANASONIC CORP	4/23/2009	Electronics provided with cooling system and it	H01L 023/427
WO-2009022094 A1	Tesla Engineering Ltd. (United Kingdom), BEGG, Michael, Colin (United Kingdom), GOLDIE, Frederick, Thomas, David (United Kingdom)	2/19/2009	COOLING METHODS	H01F 006/04
GB-2451708 A	Tesla Engineering Limited (United Kingdom)	2/11/2009	Superconducting coil cooling	H01F 006/04
DE-102008002904 A1	General Electric Co., Schenectady, N.Y., US	1/2/2009	Superconducting magnets cooled by means of thermal transfer tube with ceramic coil body	H01F 006/00
EP-1310035 B1	Siemens Aktiengesellschaft (Germany, 80333 München)	12/3/2008	SUPERCONDUCTOR DEVICE COMPRISING A COOLING UNIT FOR COOLING A ROTATING SUPRACONDUCTIVE COIL	H01L 039/04
US-7453041 B2	American Superconductor Corporation (United States, Devens, MA)	11/18/2008	Method and apparatus for cooling a superconducting cable	H01B 012/00
JP-04132130 B2	独立行政法人理化学研究所, 独立行政法人情報通信研究機構, 三井金属鉱業株式会社, 住友重機械工業株式会社, 株式会社日本計器製作所, 太田 浩	8/13/2008	Cooling system for high temperature superconducting magnetic shield body	H01L 039/00
JP-04126029 B2	富士通株式会社	7/30/2008	High-frequency circuit cooling system	H01L 039/04
JP-04099314 B2	AMERICAN SUPERCONDUCTOR CORPORATION, アメリカン	6/11/2008	Superconductor rotor cooling system	H01L 039/04

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	スーパーコンダクター コーポレイション, レリアンス エレクトリック インダストリアル カンパニー; Reliance Electric Industrial Company			
DE-102006035093 B3	Siemens AG, 80333 München, DE	4/3/2008	Cooling device of a system of at least two magnets	H01F 006/04
JP-2007324611 A	SUMITOMO HEAVY IND LTD, NIPPON KEIKI WORKS LTD, OTA HIROSHI, INSTITUTE OF PHYSICAL & CHEMICAL RESEARCH, MITSUI MINING & SMELTING CO LTD, NATIONAL INSTITUTE OF INFORMATION & COMMUNICATIONTECHNOLOGY	12/13/2007	Cooling system for high temperature superconducting magnetic shield body	H01L 039/04
JP-04019014 B2	株式会社ワイ・ワイ・エル	12/5/2007	Thermoelectric cooling type power lead	H01L 039/04
JP-2007526625 A	スーパーパワー インコーポレイテッド	9/13/2007	Cryogenic temperature cooling method for high-temperature superconductor device and device	H01L 039/04
US-20070188282 A1		8/16/2007	Supplementary transformer cooling in a reactive power compensation system	H01F 027/08
EP-1504458 B1	Siemens Aktiengesellschaft (Federal Republic of Germany, 80333 Munchen)	7/18/2007	SUPERCONDUCTOR TECHNOLOGY-RELATED DEVICE COMPRISING A SUPERCONDUCTING MAGNET AND A COOLING UNIT	H01F 006/04
DE-69932106 T2	AMERICAN SUPERCONDUCTOR CORP (United States of America), RELIANCE ELECTRIC IND CO (United States of America)	6/21/2007	System for cooling of a superconducting rotor	H01L 039/04
JP-2007150318 A	GENERAL ELECTRIC CO <GE>	6/14/2007	Cold mass accompanying the coupler of superconducting magnet and discrete route and in substance conductivity for refrigerant cooling circuit	H01F 006/00
GB-2432898 A	General Electric Company (United States of America)	6/6/2007	CRYOGENIC COOLING CIRCUIT ARRANGEMENT TO AVOID DIRECT CONDUCTIVE THERMAL ENGAGEMENT OF THE INLET PATH WITH A COUPLER FOR A SUPERCONDUCTING MAGNET	H01F 006/04
JP-2007134703 A	GENERAL ELECTRIC CO <GE>	5/31/2007	Cooling system for superconducting magnet	H01F 006/04
US-20070120630 A1		5/31/2007	COLD MASS CRYOGENIC COOLING CIRCUIT INLET PATH AVOIDANCE OF DIRECT CONDUCTIVE THERMAL ENGAGEMENT WITH SUBSTANTIALLY CONDUCTIVE COUPLER FOR SUPERCONDUCTING MAGNET	H01F 006/00
GB-2432725 A	General Electric Company (United States of America)	5/30/2007	A cooling system with a discrete thermally conductive path between a superconductive coil and a cryogenic circuit	H01F 006/04
US-20070042514 A1		2/22/2007	Method and apparatus for cooling a blade server	H01L 021/66
US-20060283620 A1	American Superconductor Corporation (United States)	12/21/2006	Method and apparatus for cooling a superconducting cable	H01B 012/00
JP-03860070 B2	株式会社ワイ・ワイ・エル	12/20/2006	Thermoelectric cooling type power lead	H01L 039/04
JP-2006332577 A	NIPPON STEEL CORP	12/7/2006	Cooling method of magnetic method of manufacturing method of oxide superconductor coil, oxide superconductor coil, oxide superconductor coil, oxide superconductor coil and magnet system	H01F 006/06
JP-2006332577 A	NIPPON STEEL CORP	12/7/2006	OXIDE SUPERCONDUCTOR COIL, ITS MANUFACTURING METHOD, ITS EXCITING METHOD, ITS COOLING METHOD AND MAGNET SYSTEM	H01F 006/06
US-20060260837 A1		11/23/2006	Conduction cooling of a superconducting cable	H01B 012/00
DE-	Max-Planck-Gesellschaft zur	8/24/2006	Power supply device for a low temperature	H01F 006/04

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102005005780 A1	Förderung der Wissenschaften e.V., 80539 München, DE		conductor and method for the cooling of a power supply device	
GB-2420668 A	Siemens Aktiengesellschaft (Germany(3))	5/31/2006	Superconducting switch cooled by pipeline with constriction	H01L 039/20
JP-2005333387 A	Fujitsu Ltd	12/2/2005	High-frequency circuit cooling system	H01P 007/08
EP-1544873 A2	Siemens Aktiengesellschaft (Federal Republic of Germany, 80333 Munchen)	6/22/2005	Cooling system for a superconductor	H01F 006/04
WO-2005020245 A2	The Regents of the University of California (United States)	3/3/2005	CONDUCTION COOLING OF A SUPERCONDUCTING CABLE	H01B 000/000
EP-1504458 A1	Siemens Aktiengesellschaft (Federal Republic of Germany, 80333 Munchen)	2/9/2005	SUPERCONDUCTOR TECHNOLOGY-RELATED DEVICE COMPRISING A SUPERCONDUCTING MAGNET AND A COOLING UNIT	H01F 006/04
DE-10317733 B3	Siemens AG, 80333 München, DE	2/3/2005	Cooling of a superconducting transformer with supercooled nitrogen	H01F 036/00
JP-2004327874 A	HITACHI HIGH-TECHNOLOGIES CORP	11/18/2004	Cooling system, bio magnetic measurement device provided with amount of refrigerant consumption surveillance function	H01L 039/04
US-20040178517 A9		9/16/2004	Split body peltier device for cooling and power generation applications	H01L 023/38
JP-2004179413 A	Mitsubishi Electric Corp	6/24/2004	COOLING TYPE SUPERCONDUCTING MAGNET DEVICE	H01F 006/00
JP-2004146830 A	PRAXAIR TECHNOL INC	5/20/2004	Multiple level cooling for high temperature superconduction	H01L 039/04
JP-2004119966 A	PRAXAIR TECHNOL INC	4/15/2004	Superconductor cooling system of cryogenic temperature	H01L 039/04
JP-2004119966 A	PRAXAIR TECHNOL INC	4/15/2004	CRYOGENIC SUPERCONDUCTOR COOLING SYSTEM	H01L 039/04
JP-2004006859 A	YYL:KK	1/8/2004	Thermoelectric cooling type power lead	H01L 039/04
WO-2003098645 A1	Siemens Aktiengesellschaft (Germany)	11/27/2003	SUPERCONDUCTOR TECHNOLOGY-RELATED DEVICE COMPRISING A SUPERCONDUCTING MAGNET AND A COOLING UNIT	H01F 006/04
DE-10217092 A1	Linde AG, 65189 Wiesbaden, DE	11/6/2003	Cooling of high-temperature superconductors	H01B 012/16
JP-03450318 B2	株式会社ワイ・ワイ・エル	9/22/2003	Thermoelectric cooling type power lead	H01F 006/00
US-20030116869 A1		6/26/2003	Split body peltier device for cooling and power generation applications	H01L 023/38
JP-2003051625 A	株式会社ワイ・ワイ・エル	2/21/2003	Thermoelectric cooling type power lead	H01L 039/04
JP-2003051625	YYL:KK	2/21/2003	THERMOELECTRIC COOLING POWER LEAD	H01L 039/04
JP-03377350 B2	株式会社ワイ・ワイ・エル	2/17/2003	Thermoelectric cooling type power lead	H01F 006/00
JP-2003046150 A	株式会社ワイ・ワイ・エル	2/14/2003	Thermoelectric cooling type power lead	H01L 039/04
JP-2003046150	YYL:KK	2/14/2003	THERMOELECTRIC COOLING-TYPE POWER LEAD	H01L 039/04
DE-10117847 C1	Siemens AG, 80333 München, DE	2/6/2003	Transformer with activated liquid cooling	H01F 027/10
JP-2002270422	TOSHIBA CORP, TOKYO ELECTRIC POWER CO INC:THE	9/20/2002	SUPERCONDUCTING DEVICE AND ITS COOLING SYSTEM	H01F 006/04
US-6365821 B1	Intel Corporation (United States of America, Santa Clara, CA)	4/2/2002	Thermoelectrically cooling electronic devices	H01L 037/00
EP-820071 B1	Sumitomo Electric Industries, Ltd (Japan, Osaka-shi, Osaka-fu 541)	1/9/2002	Cooling method and energizing method of superconductor	H01F 006/04
EP-1134754 A1	Non-Equilibring Materials and Processing (NEMP) (Germany)	9/19/2001	Superconductor cooling process	H01F 006/04
EP-1134753	Non-Equilibring Materials and	9/19/2001	Superconductor cooling process	H01F 006/04

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A1	Processing (NEMP) (Germany)			
DE-19604805 C2	Siemens AG, 80333 München, DE	3/8/2001	Installation of the superconductivity technique with a superconducting device indirectly to cool and a power supply device	H01F 006/06
JP-2001028211	Mitsubishi Electric Corp	1/30/2001	FORCED COOLING TYPE SUPERCONDUCTOR	H01B 012/16
JP-2000348925	TOSHIBA CORP	12/15/2000	MANUFACTURE OF FORCED COOLING SUPERCONDUCTING COIL	H01F 006/06
EP-1026755 A1	Sumitomo Electric Industries, Ltd. (Japan)	8/9/2000	METHOD AND DEVICE FOR COOLING SUPERCONDUCTOR	H01L 039/04
EP-1009039 A2	Sumitomo Electric Industries, Ltd. (Japan)	6/14/2000	Apparatus for cooling superconductor	H01L 039/00
DE-19904822 C1	MESSER GRIESHEIM GMBH Frankfurt Airport Center 1, C9, 60549 Frankfurt, DE	5/18/2000	Method and device for cooling of power supplies	H01B 012/16
JP-2000123652	Hitachi Cable Ltd	4/28/2000	FORCED COOLING TYPE SUPERCONDUCTING CONDUCTOR	H01B 012/16
JP-2000067665	Hitachi Cable Ltd	3/3/2000	FORCED COOLING SUPERCONDUCTOR	H01B 012/16
JP-03010343 B2	ダイムラー―ベンツ・アクチエンゲゼルシャフト	2/21/2000	Micro shaped cooling system and that manufacturing method	H01L 023/473
WO-9962127 A1	Sumitomo Electric Industries, Ltd. (Japan)	12/2/1999	METHOD AND DEVICE FOR COOLING SUPERCONDUCTOR	H01L 039/04
DE-19625748 C2	Forschungszentrum Jülich GmbH, 52428 Jülich, DE, Institut für Luft- und Kältetechnik Gemeinnützige Gesellschaft mbH, 01309 Dresden, DE	9/2/1999	Device for cooling of electronic components, preferably sensors	H01L 023/34
JP-11233334 A	株式会社日立製作所	8/27/1999	Conduction cooling formula superconducting magnetic device	H01F 006/04
JP-11096953 A	Hitachi Ltd	4/9/1999	Cooling sample experimental device	H01J 037/20
JP-10335137	SUMITOMO ELECTRIC IND LTD	12/18/1998	COOLING METHOD AND CONDUCTING METHOD FOR SUPERCONDUCTOR	H01F 006/04
JP-10313136 A	住友重機械工業株式会社, 三井金属鉱業株式会社, 郵政省通信総合研究所長, 理化学研究所, 株式会社日本計器製作所	11/24/1998	Cooling system for high temperature superconducting magnetic shield body	H01L 039/04
JP-10313136	Rikagaku Kenkyusho, SUMITOMO HEAVY IND LTD, MITSUI MINING & SMELTING CO LTD, NIPPON KEIKI SEISAKUSHO:KK, YUSEISHO TSUSHIN SOGO KENKYUSHO	11/24/1998	COOLING DEVICE FOR HIGH-TEMPERATURE SUPERCONDUCTING MAGNETIC SHIELDING BODY	H01L 039/04
JP-10275719	SUMITOMO ELECTRIC IND LTD	10/13/1998	METHOD FOR COOLING SUPERCONDUCTOR	H01F 006/04
JP-10188692	FURUKAWA ELECTRIC CO LTD:THE	7/21/1998	FORCED COOLING SUPERCONDUCTOR, ITS MANUFACTURE, AND MANUFACTURE OF FORCED COOLING TYPE SUPERCONDUCTIVE COIL	H01B 012/16
JP-10134652	HITACHI CHEM CO LTD	5/22/1998	COOLING CONTAINER FOR OXIDE SUPERCONDUCTOR	H01B 012/16
JP-02726319 B2	日本電信電話株式会社	3/11/1998	Sample cooling stage	H01J 037/20
EP-0820071B	Sumitomo Electric Industries, Ltd (Japan)	1/21/1998	Cooling method and energizing method of superconductor	H01F 006/04
EP-0820071 A2	Sumitomo Electric Industries, Ltd (Japan)	1/21/1998	Cooling method and energizing method of superconductor	H01F 006/04
DE-19625764 A1	Institut für Luft- und Kältetechnik Gemeinnützige Gesellschaft mbH, 01309 Dresden, DE	1/2/1998	Device for cooling of electronic components, preferably sensors	H01L 023/34
DE-19625748 A1	Forschungszentrum Jülich GmbH, 52428 Jülich, DE, Institut für Luft- und Kältetechnik Gemeinnützige Gesellschaft mbH, 01309 Dresden, DE	1/2/1998	Device for cooling of electronic components, preferably sensors	H01L 023/34
EP-0807938 A1	Finmeccanica S.p.A. Azienda Ansaldo (Italy)	11/19/1997	A duct structure for the mechanical containment and thermal insulation of electrical superconductors cooled with cryogenic fluid	H01B 012/14
JP-02674631 B2	アメリカン テレフォン アンド テレグラフ カムパニー	11/12/1997	Coolant and simultaneous feeder of power	H01B 012/16
DE-19604805 A1	Siemens AG, 80333 München, DE	8/14/1997	Installation of the superconductivity technique with a superconducting device indirectly to cool and a power supply device	H01F 006/06
EP-0789368	Siemens Aktiengesellschaft	8/13/1997	Superconducting installation with a	H01F 006/06

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B1	(Germany)		superconducting device to be cooled indirectly and with a current supply system	
JP-09148122	KOBE STEEL LTD	6/6/1997	SUPERCONDUCTIVE SWITCH FOR CONDUCTION COOLING SUPERCONDUCTIVE MAGNET	H01F 006/04
JP-09147636	MITSUBISHI HEAVY IND LTD	6/6/1997	FORCED COOLING SUPERCONDUCTIVE CONDUCTOR	H01B 012/16
JP-09082518	Hitachi Ltd	3/28/1997	DIP COOLING TYPE SUPERCONDUCTING DEVICE	H01F 006/04
JP-09036444	NIPPON STEEL CORP	2/7/1997	COOLING METHOD FOR SUPERCONDUCTING COIL	H01L 039/04
JP-08293573 A	Daimler Benz AG	11/5/1996	Micro shaped cooling system and that manufacturing method	H01L 023/473
JP-08236342 A	UNIE NET:KK	9/13/1996	Thermoelectric cooling type power lead	H01F 006/06
DE-19502549 A1	Siemens AG, 80333 München, DE	8/1/1996	Magnetic device with superconducting winding forciert to cool	H01F 006/04
EP-0724273 A2	Siemens Aktiengesellschaft	7/31/1996	Magnet device with superconducting winding to be cooled by enforced cooling	H01F 006/04
JP-08088117	SUMITOMO ELECTRIC IND LTD	4/2/1996	CURRENT LEAD FOR REFRIGERATOR COOLING TYPE SUPERCONDUCTIVE COIL	H01F 006/00
JP-08083520	TOSHIBA CORP	3/26/1996	FORCED COOLING TYPE SUPERCONDUCTOR	H01B 012/16
JP-08078736	DOWA MINING CO LTD, SHIMIZU CORP	3/22/1996	COOLING STRUCTURE OF OXIDE SUPERCONDUCTOR	H01L 039/02
JP-08017264	MITSUBISHI HEAVY IND LTD	1/19/1996	FORCED COOLING TYPE SUPERCONDUCTOR	H01B 012/16
JP-07321381 A	CHODENDO SENSOR KENKYUSHO:KK	12/8/1995	SQUID containment vessel and SQUID cooling method	H01L 039/04
JP-07321380 A	CHODENDO SENSOR KENKYUSHO:KK	12/8/1995	SQUID containment vessel and SQUID cooling method	H01L 039/04
JP-07070759 B2	株式会社超伝導センサ研究所	7/31/1995	Cooling method of oxide superconducting magnetic shield vessel	H01L 039/04
JP-07169616	TOSHIBA CORP	7/4/1995	COOLING STRUCTURE OF SUPERCONDUCTIVE MAGNET	H01F 006/04
JP-07141931	CHUBU ELECTRIC POWER CO INC	6/2/1995	HOLLOW PORTION COOLING TYPE PLURAL CORE WIRE HIGH TEMPERATURE SUPERCONDUCTOR	H01B 012/12
US-5415699	Massachusetts Institute of Technology (United States of America, Cambridge, MA)	5/16/1995	Superlattice structures particularly suitable for use as thermoelectric cooling materials	H01L 035/16
JP-07086642	SUMITOMO HEAVY IND LTD	3/31/1995	CONDUCTION COOLING SUPERCONDUCTION MAGNET DEVICE	H01L 039/04
JP-07085735	TOSHIBA CORP	3/31/1995	FORCED-COOLING SUPERCONDUCTOR	H01B 012/16
JP-07065770	CENTRAL RES INST OF ELECTRIC POWER IND	3/10/1995	ELECTRON MICROSCOPE WITH CURRENT-CARRYING FUNCTION WHILE COOLING, AND SUPERCONDUCTIVE CURRENT DISTRIBUTION MEASURING METHOD BY USING THE ELECTRON MICROSCOPE	H01J 037/20
DE-69104462 T2	GEC ALSTHOM S.A., PARIS, FR	2/9/1995	Method for the cooling of a current supply for electrical installations with very low temperatures and device for implementation of the method.	H01F 006/00
FR-2674672 B1	Mitsubishi Electric Corp (Japan)	11/25/1994	COOLING DEVICE FOR SUPERCONDUCTIVE MAGNET OF ACCUMULATION THE TYPE OF THE MULTI STAGE COLD.	H01F 005/08
JP-06325930	KOBE STEEL LTD	11/25/1994	COOLING SYSTEM OF AC MAGNET USING OXIDE SUPERCONDUCTING WIRE	H01F 007/22
DE-68913187 T2	Hughes Aircraft Co., Los Angeles, Calif., US	11/17/1994	PELTIER-COOLING DEVICE WITH SUPERCONDUCTOR-SEMICONDUCTOR-COMPOUND.	H01L 035/22
JP-06275875	SUMITOMO HEAVY IND LTD	9/30/1994	CONDUCTION COOLING-TYPE SUPERCONDUCTING ELECTROMAGNET DEVICE	H01L 039/04
JP-06073334 B2	ゼネラル・エレクトリック・カンパニイ	9/14/1994	Superconducting switch for conduction cooling formula superconducting magnet	H01F 007/22
US-5347251	Martin Marietta Corporation (United States of America, San Diego, CA)	9/13/1994	Gas cooled high voltage leads for superconducting coils	H01F 007/22
JP-06188466	SUMITOMO ELECTRIC IND LTD	7/8/1994	SUPERCONDUCTOR MAGNET COOLING SYSTEM	H01L 039/04
DE-68913187 D1	Hughes Aircraft Co (United States of America)	3/24/1994	PELTIER-COOLING DEVICE WITH SUPERCONDUCTOR-SEMICONDUCTOR-COMPOUND.	H01L 035/22
JP-05145127	CHODENDO SENSOR KENKYUSHO:KK	6/11/1993	COOLING METHOD FOR OXIDE SUPER CONDUCTIVE MAGNETIC SHIELDING	H01L 039/04

Publication Number	Assignee	Publication Date	Title	Main IPC Class
			HOLDER	
EP-0541819 B1	Nippon Steel Corporation (Japan)	5/19/1993	METHOD FOR COOLING OXIDE SUPERCONDUCTOR COIL	H01F 006/02
EP-0541819 A1	Nippon Steel Corporation	5/19/1993	METHOD AND APPARATUS FOR COOLING OXIDE SUPERCONDUCTOR COIL	H01F 007/22
JP-05036526	Hitachi Ltd	2/12/1993	METHOD FOR COOLING FORCED COOLING CONDUCTOR	H01F 007/22
WO-9222077 A1	Nippon Steel Corporation, MORITA, Mitsuru Nippon Steel Corporatio	12/10/1992	METHOD AND APPARATUS FOR COOLING OXIDE SUPERCONDUCTOR COIL	H01F 007/22
JP-04321284	WESTINGHOUSE ELECTRIC CORP <WE>	11/11/1992	VAPOR-COOLING POWER LEAD FOR CRYOSTAT	H01L 039/04
FR-2674672 A1	Mitsubishi Denki KK (Japan)	10/2/1992	Cooling device for superconductive magnet of accumulation the type of the cold at étagesmultiples	H01F 005/08
FR-2669470 A1	GEC Alsthom SA (France)	5/22/1992	Method of cooling of a supply of current for electrical apparatus at very bassetempérature and device for its implementation	H01R 004/68
JP-04142006	FURUKAWA ELECTRIC CO LTD:THE	5/15/1992	COOLING CONTAINER FOR SUPPORTING SUPERCONDUCTING MATERIAL	H01F 007/22
US-5105177	Hitachi, Ltd. (Japan, Tokyo), Hitachi Engineerings and Services Co I, Ltd. (Japan, Ibaraki)	4/14/1992	Superconducting magnet apparatus, cooling system therefor, and electromagnetic levitation traveling equipment incorporating the same	H01F 001/00
US-5093645	General Electric Company (United States of America, Schenectady, NY)	3/3/1992	Superconductive switch for conduction cooled superconductive magnet	H01F 001/00
JP-04065883	NIKKO KYODO CO LTD, HASHIMOTO TAKAKUNI	3/2/1992	PELTIER COOLER AND COOLING METHOD THEREFOR	H01L 035/32
US-5073679	GEC Alsthom SA (France, Paris)	12/17/1991	Superconducting conductor having multiple transposed strands with internal cooling channels, and method of manufacture	H01B 012/00
JP-03248580	SUMITOMO HEAVY IND LTD	11/6/1991	COOLING METHOD OF OXIDE SUPERCONDUCTOR	H01L 039/04
FR-2649529 B1	ALSTHOM GEC (France)	9/20/1991	THE CONDUCTIVE SUPERCONDUCTOR AT MULTIPLE STRANDS TRANSPOSES TO INTERNAL CHANNELS OF COOLING AND ITS MANUFACTURING METHOD	H01B 012/08
GB-2207321 B	Outokumpu Oy (Finland)	7/3/1991	COOLING ELEMENT	H01L 039/22
JP-03133008	MITSUI MINING & SMELTING CO LTD	6/6/1991	COOLING APPARATUS OF CERAMICS SUPERCONDUCTOR	H01B 012/16
US-5006505	Hughes Aircraft Company (United States of America, Los Angeles, CA)	4/9/1991	Peltier cooling stage utilizing a superconductor-semiconductor junction	H01L 025/04
FR-2649529 A1	GEC Alsthom SA (France)	1/11/1991	THE CONDUCTIVE SUPERCONDUCTOR AT MULTIPLE STRANDS TRANSPOSES TO INTERNAL CHANNELS OF COOLING AND ITS MANUFACTURING METHOD	H01B 012/08
EP-0406798 B1	GEC Alsthom SA (France)	1/9/1991	Superconductor with multiple transposed filaments with internal cooling channels and method for making the same	H01L 039/24
EP-0406798 A1	GEC Alsthom SA	1/9/1991	Superconductor with multiple transposed filaments with internal cooling channels and method for making the same	H01L 039/24
EP-0381754 B1	Hughes Aircraft Company (United States of America, Los Angeles, CA)	8/16/1990	PELTIER COOLING STAGE UTILIZING A SUPERCONDUCTOR-SEMICONDUCTOR JUNCTION	H01L 035/22
EP-0381754 A1	Hughes Aircraft Company	8/16/1990	PELTIER COOLING STAGE UTILIZING A SUPERCONDUCTOR-SEMICONDUCTOR JUNCTION	H01L 035/22
FR-2596193 B1	KERNFORSCHUNGSZ KARLSRUHE (Germany(3))	6/8/1990	SUPERCONDUCTIVE CABLE AT INTERNAL COOLING	H01B 012/06
US-4910742	Galram (Israel, Haifa)	3/20/1990	Method and apparatus for the cooling of gas lasers	H01S 003/00
JP-02066812	SHOWA ELECTRIC WIRE & CABLE CO LTD	3/6/1990	MANUFACTURE OF FORCED COOLING TYPE SUPERCONDUCTOR	H01B 013/00
WO-9001806 A1	Hughes Aircraft Company	2/22/1990	PELTIER COOLING STAGE UTILIZING A SUPERCONDUCTOR-SEMICONDUCTOR JUNCTION	H01L 035/22
EP-0354722 A2	Hitachi, Ltd.	2/14/1990	Heat transfer system especially for cooling semiconductor devices	H01L 023/433
EP-0350266 B1	General Electric Company (United States of America, Schenectady, NY)	1/10/1990	Coupling a cryogenic cooler to a body to be cooled	H01F 007/22
EP-0350266 A2	General Electric Company	1/10/1990	Coupling a cryogenic cooler to a body to be cooled	H01F 007/22
JP-01112612	RICOH CO LTD	5/1/1989	ABNORMAL COOLING TEMPERATURE SENSING METHOD IN POWER TRANSMISSION	H01B 012/16
JP-01069004	Hitachi Ltd, Hitachi Cable Ltd	3/15/1989	APPARATUS FOR COOLING	H01F 007/22

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			SUPERCONDUCTOR	
GB-2207321 A	* OUTOKUMPU OY	1/25/1989	Thermoelectric cooling element	H01L 039/22
FR-2617643 A1	Outokumpu Oy (Finland)	1/6/1989	ELEMENT OF COOLING	H01L 035/28
JP-63266888	Hitachi Ltd	11/2/1988	COOLING DEVICE	H01L 039/04
FR-2596193 A1	Kernforschungszentrum Karlsruhe (Germany(3))	9/25/1987	SUPERCONDUCTIVE CABLE AT INTERNAL COOLING	H01B 012/06
US-4692560	Hitachi, Ltd. (Japan, Tokyo)	9/8/1987	Forced flow cooling-type superconducting coil apparatus	H01B 007/34
EP-209134 A1	Hitachi, Ltd. (Japan)	1/21/1987	Forced flow cooling-type superconducting coil apparatus.	H01F 005/08
JP-61179508	Hitachi Ltd	8/12/1986	FORCED COOLING SUPERCONDUCTIVE COIL DEVICE	H01F 007/22
JP-60014409	Hitachi Ltd	1/25/1985	FORCED COOLING SUPERCONDUCTIVE COIL APPARATUS	H01F 005/08
US-4394634		7/19/1983	Vapor cooled current lead for cryogenic electrical equipment	H01F 007/22
US-4334123	Hitachi, Ltd. (Japan, Tokyo)	6/8/1982	Internal cooling type superconductor	H01B 012/00
FR-2491262 A1	Westinghouse Electric Corp (United States of America)	4/2/1982	COOLING SYSTEM AT RAPID START FOR ANTITHERMAL SHIELD OF GENERATOR AT SUPRACONDUCTION	H01L 039/00
US-4277769	Siemens Aktiengesellschaft (Germany, Berlin and Munich)	7/7/1981	Arrangement for cooling a superconduction magnet coil winding	H01F 007/22
JP-55096687	Hitachi Ltd	7/23/1980	DEVICE FOR COOLING SUPERCONDUCTIVE MAGNET	H01L 039/04
US-4209657	Tokyo Shibaura Electric Co., Ltd. (Japan, Kawasaki)	6/24/1980	Apparatus for immersion-cooling superconductor	H01L 039/02
FR-2418529 A1	ENERGETICHESKY INSTITUT IMENI	9/21/1979	CABLE COOLED TO ALTERNATING POLYPHASE CURRENT	H01B 012/00
GB-1487933 A	Siemens AG	10/5/1977	SUPERCONDUCTIVE ELECTRIC CABLE AND COOLING APPARATUS THEREFOR	H01B 012/00
GB-1482967 A	Siemens AG	8/17/1977	SUPERCONDUCTIVE ELECTRIC CABLE AND COOLING APPARATUS THEREFOR	H01B 012/00
US-4038492	Siemens Aktiengesellschaft (Munich)	7/26/1977	Current feeding device for electrical apparatus with conductors cooled to a low temperature	H01B 012/00
US-4024363	Siemens Aktiengesellschaft (Munich)	5/17/1977	Shorting contacts for closing a superconducting current path operated by a bellows arrangement responsive to the pressure of a cryogenic medium used in cooling the contacts	H01H 001/62
US-4020275	The United States of America as represented by the United States Energy Research and Development Administration (United States of America, Washington, DC)	4/26/1977	Superconducting cable cooling system by helium gas at two pressures	H01B 012/00
US-4020274	The United States of America as represented by the United States Energy Research and Development Administration (United States of America, Washington, DC)	4/26/1977	Superconducting cable cooling system by helium gas and a mixture of gas and liquid helium	H01B 012/00
US-3959576	Siemens Aktiengesellschaft (Munich)	5/25/1976	Apparatus for supplying power to electrical devices having conductors cooled to a low temperature	H01B 007/34
US-3956724	Westinghouse Electric Corporation (United States of America, Pittsburgh, PA)	5/11/1976	Superconductive winding with cooling passages	H01F 007/22
FR-2286485 A1	Siemens AG (Germany(3))	4/23/1976	DEVICE OF ATTACHMENT OR OF HOLDING OF AN ELECTRICAL WINDING COOLED TO LOW TEMPERATURE AT THE INTERIOR OF A VACUUM CHAMBER	H01F
US-3950606	Siemens Aktiengesellschaft (Munich)	4/13/1976	Apparatus and method for cooling a superconducting cable	H01B 012/00
US-3946141	Siemens Aktiengesellschaft (Munich)	3/23/1976	Cooling apparatus for an electric cable	H01B 012/00
US-3917897	Linde Aktiengesellschaft (Wiesbaden)	11/4/1975	Low temperature cable system and method for cooling same	H01B 007/34
US-3900702	Siemens Aktiengesellschaft (Munich)	8/19/1975	Ribbon-shaped conductor arrangement for superconductors which permits ease of cooling	H01V 011/00
US-3766502		10/16/1973	COOLING DEVICE FOR SUPERCONDUCTING COILS	H01F 007/22
GB-1330250 A	VEREINIGTE DRAHT- UND KABELWERKE AG	9/12/1973	CABLES ADAPTED IN USE TO HAVE A LOW-TEMPERATURE COOLING-LIQUID FLOW THERETHROUGH	H01B 009/00
GB-1310424 A	Siemens AG	3/21/1973	ELECTRIC CABLES EMPLOYING CURRENT CONDUCTORS COOLED TO LOW TEM PERATURES	H01B 007/34

Publication Number	Assignee	Publication Date	Title	Main IPC Class
GB-1285844 A	Commissariat A L'Energie Atomique (France)	8/16/1972	COOLING DEVICE FOR SUPERCONDUCTING COILS	H01F 007/22
GB-1219542 A	Osterreichische Studiengesellschaft fur Atomenergie Ges. m.b.H. (Austria)	1/20/1971	A DEVICE FOR HOLDING AND COOLING A SPECIMEN IN AN ELECTRON MICROSCOPE	H01J 037/20

Query: superconductor <in> All available text fields <and> cable <in> Abstract <and> H01B 12 <in> IPC Class
Table Name Patents

Publication Number	Assignee	Publication Date	Title	Main IPC Class
GB-1190949 A	Siemens Aktiengesellschaft (Germany(3))	5/6/1970	Superconducting Electrical Power Cables	H01B 012/02
GB-1201774 A	Imperial Metal Industries (Kynoch) Limited	8/12/1970	IMPROVEMENTS RELATING TO ELECTRICAL CONDUCTORS	H01B 012/10
GB-1206473 A	British Insulated Callender's Cables Limited (United Kingdom), Central Electricity Generating Board (United Kingdom)	9/23/1970	IMPROVEMENTS IN ELECTRIC POWER CABLES	H01B 012/16
GB-1219822 A	Siemens Aktiengesellschaft (Germany(3))	1/20/1971	SUPERCONDUCTOR POWER CABLE INSTALLATIONS	H01B 012/16
GB-1284531 A	Central Electricity Generating Board (United Kingdom)	8/9/1972	IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTING CABLES	H01B 012/12
GB-1285441 A	Central Electricity Generating Board (United Kingdom)	8/16/1972	IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTING CABLES	H01B 012/12
GB-1387334 A	Linde AG	3/12/1975	ELECTRICAL CONDUCTORS	H01B 012/00
GB-1389414 A	Siemens AG	4/3/1975	ELECTRIC CABLES	H01B 012/00
GB-1389675 A	BBC BROWN BOVERI CO LTD	4/3/1975	INSULATED ELECTRICAL CONDUCTOR	H01B 012/00
GB-1390045 A	United States Atomic Energy Commission	4/9/1975	TRANSMISSION LINE	H01B 012/00
US-3946141	Siemens Aktiengesellschaft (Munich)	3/23/1976	Cooling apparatus for an electric cable	H01B 012/00
US-3947622	Massachusetts Institute of Technology (United States of America, Cambridge, MA)	3/30/1976	Vacuum insulated A-C superconducting cables	H01B 012/00
US-3950606	Siemens Aktiengesellschaft (Munich)	4/13/1976	Apparatus and method for cooling a superconducting cable	H01B 012/00
US-3984618	Siemens Aktiengesellschaft (Munich)	10/5/1976	Support body for the conductors of a low temperature cable	H01B 012/00
GB-1455333 A	Siemens AG	11/10/1976	ELECTRICAL CONDUCTOR ASSEMBLIES EMPLOYING SUPERCONDUCTOR CON DUCTORS	H01B 012/00
US-4020275	The United States of America as represented by the United States Energy Research and Development Administration (United States of America, Washington, DC)	4/26/1977	Superconducting cable cooling system by helium gas at two pressures	H01B 012/00
US-4020274	The United States of America as represented by the United States Energy Research and Development Administration (United States of America, Washington, DC)	4/26/1977	Superconducting cable cooling system by helium gas and a mixture of gas and liquid helium	H01B 012/00
GB-1482967 A	Siemens AG	8/17/1977	SUPERCONDUCTIVE ELECTRIC CABLE AND COOLING APPARATUS THEREFOR	H01B 012/00
GB-1487933 A	Siemens AG	10/5/1977	SUPERCONDUCTIVE ELECTRIC CABLE AND COOLING APPARATUS THEREFOR	H01B 012/00
US-4079187	BBC Brown Boveri & Company Limited (Switzerland, Baden)	3/14/1978	Superconductor	H01B 012/00
GB-1535971 A	SHOWA ELECTRIC WIRE & CABLE CO LTD, TOKYO SHIBAURA ELECTRIC CO LTD	12/13/1978	METHOD OF FABRICATING COMPOSITE SUPERCONDUCTORS	H01B 012/00
GB-2003311 A	Vacuumschmelze GmbH	3/7/1979	SUPERCONDUCTING COMPOSITE CONDUCTORS	H01B 012/00
FR-2400243 A1	Vacuumschmelze GmbH (Germany(3))	3/9/1979	THE SUPERCONDUCTIVE BEAM COMBINES AND METHOD FOR ITS MANUFACTURE	H01B 012/00
JP-54114784	FURUKAWA ELECTRIC CO LTD:THE	9/7/1979	SUPERCONDUCTIVE CABLE	H01B 012/00
FR-2418529 A1	ENERGETICHESKY INSTITUT IMENI	9/21/1979	CABLE COOLED TO ALTERNATING POLYPHASE CURRENT	H01B 012/00
US-4169964	BBC Brown, Boveri & Company Limited (Switzerland, Baden)	10/2/1979	Electrical superconductor	H01B 012/00
US-4176238	Gosudarstvenny Nauchno-Issledovatelsky Energetichesky Institut Imeni G.M. Krzhizhanovskogo (ENIN) (Soviet Union, Moscow)	11/27/1979	Cooled multiphase ac cable	H01B 012/00
US-4184042	Gosudarstvenny Nauchno-Issledovatelsky Energetichesky Institut Imeni G.M. Krzhizhanovskogo (Soviet Union, Moscow)	1/15/1980	Multisection superconducting cable for carrying alternating current	H01B 012/00
US-4195199	Vacuumschmelze GmbH (Germany, Hanau)	3/25/1980	Superconducting composite conductor and method of manufacturing same	H01B 012/00

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FR-2436482 A1	Kernforschungszentrum Karlsruhe (Germany(3))	4/11/1980	HIGH-VOLTAGE CABLE	H01B 012/00
FR-2448772 A1	BBC SA BROWN BOVERI ET CIE (Switzerland)	9/5/1980	SUPERCONDUCTIVE CABLE	H01B 012/00
GB-2044514 A	BBC BROWN BOVERI & CO LTD	10/15/1980	SUPERCONDUCTING CABLE	H01B 012/00
GB-2052838 A	BBC BROWN BOVERI & CO LTD	1/28/1981	SUPERCONDUCTING CABLE	H01B 012/00
US-4329539	The Furukawa Electric Co., Ltd. (Japan)	5/11/1982	Superconducting compound stranded cable	H01B 012/00
FR-2507375 A1	GOSUDARSTVENNY ENERGETICHESKY IN	12/10/1982	THE MANUFACTURING METHOD OF A SUPERCONDUCTOR STABILIZES TUBULAR TYPE AND SUPERCONDUCTOR OBTAINED BY SAID METHOD	H01B 012/00
EP-0067591 B1	Sumitomo Electric Industries Limited (Japan), Agency of Industrial Science and Technology (Japan)	12/22/1982	Al-stabilized superconductor, and method of producing the same	H01B 012/00
EP-67591 A1	Sumitomo Electric Industries (Japan), AGENCY IND SCIENCE TECHN (Japan)	12/22/1982	Al-stabilized superconductor, and method of producing the same.	H01B 012/00
US-4395584	Siemens Aktiengesellschaft (Germany, Munich)	7/26/1983	Cable shaped cryogenically cooled stabilized superconductor	H01B 012/00
US-4409425	Siemens Aktiengesellschaft (Germany, Munich)	10/11/1983	Cryogenically stabilized superconductor in cable form for large currents and alternating field stresses	H01B 012/00
GB-2140195 A	* ELECTRIC POWER RESEARCH INSTITUTE INC	11/21/1984	Cryogenic cable and method of making same	H01B 012/00
US-4506109	Sumitomo Electric (Japan, Osaka), Agency of Ind. Science and Technology (Japan, Osaka)	3/19/1985	Al-stabilized superconducting wire and the method for producing the same	H01B 012/00
US-4529837	The United States of America as represented by the United States Department of Energy (United States of America, Washington, DC)	7/16/1985	Multistrand superconductor cable	H01B 012/00
FR-2596193 A1	Kernforschungszentrum Karlsruhe (Germany(3))	9/25/1987	SUPERCONDUCTIVE CABLE AT INTERNAL COOLING	H01B 012/06
JP-63170812	Mitsubishi Electric Corp	7/14/1988	FORCED REFRIGERATION TYPE SUPERCONDUCTOR	H01B 012/16
JP-63245818	SUMITOMO ELECTRIC IND LTD	10/12/1988	SUPERCONDUCTIVE CABLE	H01B 012/02
JP-63261615	Fujikura Ltd	10/28/1988	SUPERCONDUCTIVE CABLE	H01B 012/02
US-4785142	Inco Alloys International, Inc. (United States of America, Huntington, WV)	11/15/1988	Superconductor cable	H01B 012/00
JP-63279511	Fujikura Ltd	11/16/1988	SUPERCONDUCTIVE CABLE	H01B 012/02
JP-63281316	SUMITOMO ELECTRIC IND LTD	11/17/1988	SUPERCONDUCTIVE CABLE	H01B 012/02
JP-63284721	SUMITOMO ELECTRIC IND LTD	11/22/1988	SUPERCONDUCTING CABLE	H01B 012/02
FR-2615651 A1	Kabelmetal Electro GmbH (Germany(3))	11/25/1988	THE SUPERCONDUCTOR BEING ABLE TO BE WINDS AROUND A DRUM AND MANUFACTURING METHOD	H01B 012/02
JP-63291312	Fujikura Ltd	11/29/1988	SUPERCONDUCTOR	H01B 012/02
JP-63313418	NIPPON TELEGR & TELEPH CORP <NTT>	12/21/1988	SUPERCONDUCTIVE WIRE AND ITS MANUFACTURE	H01B 012/06
JP-63313417	NIPPON TELEGR & TELEPH CORP <NTT>	12/21/1988	SUPERCONDUCTIVE WIRE AND ITS MANUFACTURE	H01B 012/06
JP-01003911	Fujikura Ltd	1/9/1989	OXIDE SUPERCONDUCTIVE WIRE MATERIAL	H01B 012/06
JP-01003907	Fujikura Ltd	1/9/1989	OXIDE SUPERCONDUCTOR CABLE	H01B 012/02
JP-01012414	Fujikura Ltd	1/17/1989	SUPERCONDUCTING WIRE OR OXIDE	H01B 012/06
JP-01067816	FURUKAWA ELECTRIC CO LTD:THE	3/14/1989	HIGH-TEMPERATURE SUPERCONDUCTING CABLE	H01B 012/12
JP-01067811	MITSUBISHI CABLE IND LTD	3/14/1989	SUPERCONDUCTING CABLE	H01B 012/02
JP-01082407	NIPPON TELEGR & TELEPH CORP <NTT>	3/28/1989	SUPERCONDUCTIVE WIRING CABLE AND ITS MANUFACTURE	H01B 012/06
JP-01100821	Mitsubishi Electric Corp	4/19/1989	SUPERCONDUCTOR	H01B 012/16
JP-01134811	Fujikura Ltd	5/26/1989	EXTREMELY LOW TEMPERATURE CABLE	H01B 012/02
JP-01140517	MITSUBISHI CABLE IND LTD	6/1/1989	COMPOSITE CABLE	H01B 012/06
JP-01140514	Hitachi Cable Ltd	6/1/1989	SUPERCONDUCTIVE CABLE FOR POWER TRANSMISSION	H01B 012/02
JP-01144517	Fujikura Ltd	6/6/1989	OXIDE-BASED SUPERCONDUCTIVE CABLE	H01B 012/02
US-4845308	The Babcock & Wilcox Company (United States of America, New Orleans, LA)	7/4/1989	Superconducting electrical conductor	H01B 012/00
JP-01183009	TOSHIBA CORP, JAPAN ATOM ENERGY RES INST	7/20/1989	SUPERCONDUCTOR	H01B 012/16
JP-01183008	TOSHIBA CORP, JAPAN ATOM ENERGY RES INST	7/20/1989	SUPERCONDUCTOR	H01B 012/04
US-4857675	Oxford Superconducting Technology	8/15/1989	Forced flow superconducting cable and method of	H01B 012/16

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	(United States of America, Carteret, NJ)		manufacture	
JP-01221812	Mitsubishi Electric Corp	9/5/1989	SUPERCONDUCTIVE CABLE	H01B 012/12
JP-01231217	FURUKAWA ELECTRIC CO LTD:THE	9/14/1989	SUPERCONDUCTING CABLE FOR ALTERNATE CURRENT	H01B 012/10
JP-01264111	Fujitsu Ltd	10/20/1989	SUPERCONDUCTIVE WIRING BODY	H01B 012/04
GB-2217904 A	* JUNKOSHA CO LTD (Japan)	11/1/1989	CERAMIC WIRE SUPERCONDUCTING CABLE	H01B 012/00
EP-0339800 B1	Junkosha Co. Ltd. (Japan)	11/2/1989	Electric cables	H01B 012/14
EP-0339800 A2	Junkosha Co. Ltd.	11/2/1989	Electric cables	H01B 012/14
JP-02068820	Asea Brown Boveri AG	3/8/1990	WIRE OR CABLE TYPE ELECTRIC CONDUCTOR	H01B 012/10
JP-02109211	FURUKAWA ELECTRIC CO LTD:THE	4/20/1990	SUPERCONDUCTIVE CABLE	H01B 012/00
JP-02126519	TOSHIBA CORP	5/15/1990	SUPERCONDUCTING CONDUCTOR	H01B 012/10
JP-02199713	SUMITOMO ELECTRIC IND LTD	8/8/1990	SUPERCONDUCTING CABLE	H01B 012/04
WO-9012408 A1	Sumitomo Electric Industries, Ltd., The Kansai Electric Power Co., Inc., OKUDA, Shigeru, HITOTSUYANAGI, Hajime, HAYASHI, Noriki, TAKANO, Satoshi	10/18/1990	OXIDE SUPERCONDUCTOR WIRE, METHOD OF PRODUCING THE SAME AND ARTICLE PRODUCED THEREFROM	H01B 012/06
US-4966886	Junkosha Co., Ltd. (Japan, Tokyo)	10/30/1990	Superconducting cable with continuously porous insulation	H01B 012/00
JP-02270219	GENERAL ATOMIC CO	11/5/1990	FLEXIBLE SUPERCONDUCTOR CABLE	H01B 012/08
JP-02299108	FURUKAWA ELECTRIC CO LTD:THE	12/11/1990	SUPERCONDUCTING CABLE	H01B 012/16
US-4988669	ASEA Brown Boveri Ltd. (Switzerland, Baden)	1/29/1991	Electrical conductor in wire or cable form composed of a sheathed wire or of a multiple-filament conductor based on a ceramic high-temperature superconductor	H01B 012/00
US-4994633	General Atomics (United States of America, San Diego, CA)	2/19/1991	Bend-tolerant superconductor cable	H01B 012/00
JP-03089415	SHIMIZU CORP	4/15/1991	SUPERCONDUCTIVE POWER STORAGE FACILITY	H01B 012/16
US-5010054	HALDOR TOPSOE A/S	4/23/1991	Method for the preparation of superconducting products	H01B 012/00
EP-0423354 B2	Sumitomo Electric Industries, Ltd. (Japan), The Kansai Electric Power Co., Inc. (Japan)	4/24/1991	OXIDE SUPERCONDUCTOR WIRE, METHOD OF PRODUCING THE SAME AND ARTICLE PRODUCED THEREFROM	H01B 012/00
EP-0423354 A1	Sumitomo Electric Industries, Ltd., The Kansai Electric Power Co., Inc.	4/24/1991	OXIDE SUPERCONDUCTOR WIRE, METHOD OF PRODUCING THE SAME AND ARTICLE PRODUCED THEREFROM	H01B 012/06
US-5057489	General Atomics (United States of America, San Diego, CA)	10/15/1991	Multifilamentary superconducting cable with transposition	H01B 012/00
US-5068219	Mitsubishi Materials Corporation (Japan, Tokyo)	11/26/1991	High strength superconducting wires and cables each having high current density, and a process for fabricating them	H01B 012/00
JP-04032108	SUMITOMO ELECTRIC IND LTD	2/4/1992	SUPERCONDUCTIVE CABLE	H01B 012/16
EP-0476824 A1	General Atomics	3/25/1992	Multifilamentary superconducting cable with transposition	H01B 012/10
JP-04104408	TOSHIBA CORP	4/6/1992	SUPERCONDUCTOR	H01B 012/08
JP-04123716	SUMITOMO ELECTRIC IND LTD	4/23/1992	SUPERCONDUCTING CABLE	H01B 012/10
JP-04162309	CENTRAL RES INST OF ELECTRIC POWER IND	6/5/1992	HIGH-TEMPERATURE SUPERCONDUCTING POWER CABLE	H01B 012/06
JP-04277410	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	10/2/1992	TAPE-LIKE MULTI-CORE CERAMIC SUPERCONDUCTOR AND CABLE USING IT	H01B 012/10
JP-05012935	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	1/22/1993	CERAMIC SUPERCONDUCTOR	H01B 012/16
JP-05028850	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	2/5/1993	CERAMIC SUPERCONDUCTOR	H01B 012/12
JP-05028847	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	2/5/1993	CERAMIC SUPERCONDUCTOR	H01B 012/06
DE-4227746 A1		3/18/1993	Sheath for a superconducting cable.	H01B 012/00
JP-05290648	TOSHIBA CORP	11/5/1993	SUPERCONDUCTOR	H01B 012/16
JP-05334921	FURUKAWA ELECTRIC CO LTD:THE	12/17/1993	CERAMIC SUPERCONDUCTOR	H01B 012/12
US-5272132	AT & T Bell Laboratories (United States of America, Murray Hill, NJ)	12/21/1993	Apparatus comprising a ceramic superconductive body and method for producing such a body	H01B 012/06
JP-06044834	FURUKAWA ELECTRIC CO	2/18/1994	CERAMICS SUPERCONDUCTIVE CONDUCTOR	H01B 012/12

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	LTD:THE			
JP-06103836	FURUKAWA ELECTRIC CO LTD:THE	4/15/1994	SUPERCONDUCTING STRAND	H01B 012/08
JP-06150733	TOKYO ELECTRIC POWER CO INC:THE, SUMITOMO ELECTRIC IND LTD	5/31/1994	SUPERCONDUCTOR AND MANUFACTURE THEREOF	H01B 012/02
JP-06168636	TOSHIBA CORP	6/14/1994	SUPERCONDUCTOR	H01B 012/16
JP-06187849	FURUKAWA ELECTRIC CO LTD:THE	7/8/1994	HIGH-TEMPERATURE SUPERCONDUCTING CABLE	H01B 012/08
JP-06309953	FURUKAWA ELECTRIC CO LTD:THE	11/4/1994	FLEXIBLE SUPERCONDUCTING CABLE	H01B 012/02
EP-0623937 B1	Sumitomo Electric Industries, Ltd. (Japan)	11/9/1994	High-Tc superconducting cable conductor employing oxide superconductor	H01B 012/00
EP-0623937 A2	Sumitomo Electric Industries, Ltd.	11/9/1994	High TC superconducting cable conductor employing oxide superconductor	H01B 012/00
JP-06325633	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	11/25/1994	MULTI-CORE OXIDE SUPERCONDUCTING WIRE	H01B 012/10
JP-06325631	Hitachi Ltd	11/25/1994	SUPERCONDUCTING CABLE AND DEVICE USING SAME	H01B 012/02
JP-06325629	Fujikura Ltd	11/25/1994	OXIDE SUPERCONDUCTOR, MANUFACTURE THEREOF, AND OXIDE SUPERCONDUCTING POWER CABLE HAVING THE SUPERCONDUCTOR	H01B 012/02
JP-07045136	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	2/14/1995	OXIDE SUPERCONDUCTOR	H01B 012/12
JP-07065647	TOSHIBA CORP	3/10/1995	SUPERCONDUCTOR AND SUPERCONDUCTING MAGNET DEVICE	H01B 012/14
JP-07079105 A	NEC CORP	3/20/1995	Coaxial wiring plate	H01B 012/16
JP-07094043	Fujikura Ltd, KANSAI ELECTRIC POWER CO INC:THE	4/7/1995	SUPERCONDUCTING POWER CABLE	H01B 012/16
JP-07111112	CHODENDO HATSUDEN KANREN KIKI ZAIRYO GIJUTSU KENKYU KUMIAI	4/25/1995	SLOW-RESPONSE NBTI SUPERCONDUCTOR	H01B 012/08
JP-07111111	TOSHIBA CORP	4/25/1995	SUPERCONDUCTOR AND MANUFACTURE THEREOF	H01B 012/08
JP-07141931	CHUBU ELECTRIC POWER CO INC	6/2/1995	HOLLOW PORTION COOLING TYPE PLURAL CORE WIRE HIGH TEMPERATURE SUPERCONDUCTOR	H01B 012/12
JP-07169343	TOKYO ELECTRIC POWER CO INC:THE, SUMITOMO ELECTRIC IND LTD	7/4/1995	SUPERCONDUCTING CABLE CONDUCTOR	H01B 012/12
JP-07201233	Fujikura Ltd	8/4/1995	HIGH-TEMPERATURE SUPERCONDUCTIVE POWER CABLE	H01B 012/12
JP-07201231	Fujikura Ltd	8/4/1995	HIGH-TEMPERATURE SUPERCONDUCTOR ELEMENT WIRE	H01B 012/02
JP-07201230	Fujikura Ltd	8/4/1995	CONDUCTOR FOR HIGH-TEMPERATURE SUPERCONDUCTIVE POWER CABLE, AND HIGH-TEMPERATURE SUPERCONDUCTIVE POWER CABLE	H01B 012/02
JP-07254314	FURUKAWA ELECTRIC CO LTD:THE	10/3/1995	SUPERCONDUCTING CABLE	H01B 012/08
WO-9527991 A1	New England Electric Wire Corporation	10/19/1995	SUPERCONDUCTOR CABLE AND METHOD OF MAKING	H01B 012/00
JP-07335044	SUMITOMO ELECTRIC IND LTD	12/22/1995	SUPERCONDUCTIVE CABLE	H01B 012/16
JP-08064041	SUMITOMO ELECTRIC IND LTD	3/8/1996	SUPERCONDUCTING CABLE	H01B 012/12
JP-08167332	SUMITOMO ELECTRIC IND LTD	6/25/1996	SUPERCONDUCTING CABLE	H01B 012/08
US-5545932	GEC Alsthom Electromecanique SA (France, Paris)	8/13/1996	Superconducting switch and application to a charger for a superconducting coil	H01B 012/02
JP-08212844	Fujikura Ltd	8/20/1996	OXIDE SUPERCONDUCTOR CABLE	H01B 012/02
EP-0743658 A2	The Babcock & Wilcox Company	11/20/1996	Aluminium stabilized superconductors and methods of construction	H01B 012/10
JP-08335414	SUMITOMO ELECTRIC IND LTD	12/17/1996	OXIDE SUPERCONDUCTING WIRE AND MANUFACTURE THEREOF	H01B 012/10
WO-9641352 A1	BICC Public Limited Company, BEALES, Timothy, Paul, BICC CEAT CAVI S.R.L., FRIEND, Christopher, Michael, FERRERO, Edoardo, Domenico	12/19/1996	ELECTRIC CONDUCTORS AND CABLES	H01B 012/02
JP-08339722 A	BABCOCK & WILCOX CO:THE	12/24/1996	Superconducting device stabilized at aluminum supported on seeds made of aluminum alloy	H01B 012/16
EP-0755562	New England Electric Wire	1/29/1997	SUPERCONDUCTOR CABLE AND METHOD OF	H01B 012/00

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A1	Corporation		MAKING	
JP-09050719	Fujikura Ltd	2/18/1997	SUPERCONDUCTING POWER CABLE	H01B 012/16
JP-09055127	Fujikura Ltd, CHUBU ELECTRIC POWER CO INC	2/25/1997	SUPERCONDUCTING POWER CABLE	H01B 012/16
JP-09134620	TOKYO ELECTRIC POWER CO INC:THE, SUMITOMO ELECTRIC IND LTD	5/20/1997	SUPERCONDUCTING CABLE	H01B 012/16
JP-09180553	TOKYO ELECTRIC POWER CO INC:THE, SUMITOMO ELECTRIC IND LTD	7/11/1997	FORMER FOR HIGH TEMPERATURE SUPERCONDUCTOR	H01B 012/16
EP-0786783 A1	Pirelli Cavi S.p.A.	7/30/1997	High power superconducting cable	H01B 012/16
DE-3716815 C2	kabelmetal electro GmbH, 30179 Hannover, DE	7/31/1997	Method for the continuous production of a superconductor	H01B 012/00
FR-2745416 A1	GEC Alsthom Electromecanique SA (France)	8/29/1997	SUPPLY OF MIXED HIGH VOLTAGE CURRENT	H01B 012/00
JP-09237529	FURUKAWA ELECTRIC CO LTD:THE	9/9/1997	HIGH TEMPERATURE SUPERCONDUCTIVE CABLE CONDUCTOR AND MANUFACTURE THEREOF	H01B 012/12
JP-10012058	FUJI ELECTRIC CO LTD	1/16/1998	SUPERCONDUCTIVE ELECTRICAL ENERGY TRANSMISSION CABLE	H01B 012/16
EP-0830692 A1	BICC Public Limited Company (United Kingdom), BICC CEAT CAVI S.R.L. (Italy)	3/25/1998	ELECTRIC CONDUCTORS AND CABLES	H01B 012/02
DE-3730766 C2	kabelmetal electro GmbH, 30179 Hannover, DE	5/20/1998	Method for the continuous production of a superconductor in beatable execution	H01B 012/04
JP-10247428	TOSHIBA CORP	9/14/1998	OXIDE SUPERCONDUCTIVE WIRE	H01B 012/10
JP-10283854	Fujikura Ltd	10/23/1998	TERMINATION CONNECTING PART FOR SUPERCONDUCTIVE CABLE	H01B 012/16
JP-11007845	FURUKAWA ELECTRIC CO LTD:THE	1/12/1999	SUPERCONDUCTIVE WIRE	H01B 012/08
JP-11039963	TOKYO ELECTRIC POWER CO INC:THE, SUMITOMO ELECTRIC IND LTD	2/12/1999	OXIDE SUPERCONDUCTIVE WIRE MATERIAL, STRANDED WIRE, METHOD FOR PRODUCING MATERIAL AND STRANDED WIRE THEREOF, AND OXIDE SUPERCONDUCTOR	H01B 012/10
JP-11066982	Fujikura Ltd, CHUBU ELECTRIC POWER CO INC	3/9/1999	SUPERCONDUCTING CABLE	H01B 012/08
JP-11066981	Fujikura Ltd, CHUBU ELECTRIC POWER CO INC	3/9/1999	OXIDE SUPERCONDUCTING CABLE	H01B 012/08
JP-11066980	Fujikura Ltd, CHUBU ELECTRIC POWER CO INC	3/9/1999	OXIDE SUPERCONDUCTING CABLE	H01B 012/08
JP-11066979	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	3/9/1999	SUPERCONDUCTING CABLE LINE	H01B 012/02
JP-11086649	FURUKAWA ELECTRIC CO LTD:THE	3/30/1999	OXIDE SUPERCONDUCTING CONDUCTOR, CABLE AND LAMINATED CONDUCTOR USING IT, AND MANUFACTURE OF OXIDE SUPERCONDUCTING CONDUCTOR	H01B 012/10
JP-11506261 A	シーメンス アクチエンゲゼルシャフト	6/2/1999	Alternating cable with two concentric conductor placements, comprising the 撚individual conductor	H01B 012/08
JP-11506260 A	シーメンス アクチエンゲゼルシャフト	6/2/1999	Alternating cable with 撚electric conductor	H01B 012/08
JP-11506564 A	ビーアイシーシー パブリック リミテッド カンパニー, ビーアイシーシー シート カヴィ ソシエタ アレスポンサビリタ リミタータ	6/8/1999	Conductor and cable	H01B 012/02
GB-2332557 A	* ASEA BROWN BOVERI AB (Sweden)	6/23/1999	Electrical power conducting means	H01B 012/02
JP-11203959	Fujikura Ltd, CHUBU ELECTRIC POWER CO INC	7/30/1999	SUPERCONDUCTIVE CABLE AND ITS MANUFACTURE	H01B 012/12
JP-11203958	Fujikura Ltd, CHUBU ELECTRIC POWER CO INC	7/30/1999	SUPERCONDUCTIVE CABLE AND ITS MANUFACTURE	H01B 012/12
US-5932523	Sumitomo Electric Industries, Ltd., The Tokyo Electric Power Company, Incorporated	8/3/1999	Superconducting cable conductor	H01B 012/12
US-6005194	Siemens Aktiengesellschaft (Germany, Munich)	12/21/1999	A.C. cable with two concentric conductor configurations of stranded single conductors	H01B 012/08
US-6049036		4/11/2000	Terminal for connecting a superconducting multiphase cable to a room temperature electrical equipment	H01B 012/00
WO-0039811 A1	Pirelli Cavi E Sistemi S.P.A. (Italy)	7/6/2000	ELECTRICAL POWER TRANSMISSION SYSTEM USING SUPERCONDUCTORS	H01B 012/00
GB-2350474 A	* ASEA BROWN BOVERI AB (Sweden), * ABB AB (Sweden)	11/29/2000	A flexible power cable	H01B 012/06
JP-2001006454	CHUBU ELECTRIC POWER CO INC, SUMIYOSHI FUMIO	1/12/2001	SUPERCONDUCTOR	H01B 012/08

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JP-2001006453	SUMITOMO ELECTRIC IND LTD	1/12/2001	SUPERCONDUCTING CABLE CONNECTION PART	H01B 012/00
JP-2001035272	AGENCY OF IND SCIENCE & TECHNOL, KONDO JUNJI	2/9/2001	LAMINATED SUPERCONDUCTING CABLE	H01B 012/06
JP-2001043752	SUMITOMO HEAVY IND LTD, NATL RES INST FOR METALS, SUKEGAWA ELECTRIC CO LTD	2/16/2001	HIGH TEMPERATURE SUPER CONDUCTING CABLE OF INORGANIC INSULATING OXIDE	H01B 012/02
US-6194352 B1	American Superconductor Corporation (United States of America, Westborough, MA)	2/27/2001	Multifilament composite BSCCO oxide superconductor	H01B 012/02
JP-2001067950	SUMITOMO ELECTRIC IND LTD	3/16/2001	SUPERCONDUCTING CABLE AND MANUFACTURE THEREOF	H01B 012/08
US-6255595 B1	Pirelli Cavi S.p.A.	7/3/2001	Superconducting cable with the phase conductors connected at the ends	H01B 012/00
US-6262375 B1	Electric Power Research Institute, Inc. (United States of America, Palo Alto, CA)	7/17/2001	Room temperature dielectric HTSC cable	H01B 012/16
EP-1117104 A2	Sumitomo Electric Industries, Ltd. (Japan), Tokyo Electric Power Company (Japan)	7/18/2001	Superconducting cable and method of analyzing the same	H01B 012/00
JP-2001202837	SUMITOMO ELECTRIC IND LTD	7/27/2001	SUPERCONDUCTIVE CABLE	H01B 012/16
US-6271475 B1	American Superconductor Corporation (United States of America, Westborough, MA)	8/7/2001	Low-aspect ratio superconductor wire	H01B 012/10
JP-2001291438	TOSHIBA CORP	10/19/2001	OXIDE HIGH-TEMPERATURE SUPERCONDUCTIVE CABLE	H01B 012/04
US-6313408 B1	Sumitomo Electric Industries, Inc, The Tokyo Electric Power Company, Incorporated	11/6/2001	High TC superconducting cable conductor employing oxide superconductor	H01B 012/00
EP-1151442 A1	Pirelli Cavi E Sistemi S.P.A. (Italy)	11/7/2001	ELECTRICAL POWER TRANSMISSION SYSTEM USING SUPERCONDUCTORS	H01B 012/00
JP-2001325839	SUMITOMO ELECTRIC IND LTD	11/22/2001	SUPERCONDUCTING CABLE	H01B 012/16
US-20010054509 A1		12/27/2001	Superconducting cable and method of analyzing the same	H01B 012/00
JP-2002008459	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	1/11/2002	SUPERCONDUCTING CABLE	H01B 012/12
JP-2002015629	Fujikura Ltd, CHUBU ELECTRIC POWER CO INC	1/18/2002	SUPERCONDUCTIVE CABLE	H01B 012/12
EP-1174888 A2	Brookhaven Science Associates (United States of America, Upton, NY)	1/23/2002	Superconducting power transmission cable	H01B 012/06
EP-1174887 A2	The Furukawa Electric Co., Ltd. (Japan)	1/23/2002	Superconducting cable for alternating current	H01B 012/02
WO-0215203 A1	Pirelli Cavi E Sistemi S.P.A. (Italy)	2/21/2002	SUPERCONDUCTING CABLE	H01B 012/06
US-20020027014 A1		3/7/2002	Superconducting cable for alternating current	H01B 012/00
JP-2002507820 A	メタル マニファクチャーズ リミテッド	3/12/2002	Accumulation tape	H01B 012/10
WO-0223557 A1	Southwire Company (United States of America, GA 30119 US, US)	3/21/2002	SUPERCONDUCTING CABLE	H01B 012/00
US-20020038719 A1		4/4/2002	Superconducting cable	H01B 012/00
WO-0227735 A1	IGC-SUPERPOWER, LLC (United States of America, NY 12304 US, US)	4/4/2002	LOW ALTERNATING CURRENT (AC) LOSS SUPERCONDUCTING CABLE	H01B 012/00
EP-1195777 A1	Pirelli Cavi E Sistemi S.P.A. (Italy)	4/10/2002	Superconducting cable	H01B 012/16
JP-2002109972	TOKYO ELECTRIC POWER CO INC:THE, FURUKAWA ELECTRIC CO LTD:THE	4/12/2002	SUPERCONDUCTOR	H01B 012/02
JP-2002124142 A	ブルックヘヴン サイエンス アソシエイツ	4/26/2002	Power superconducting electric transmission cable	H01B 012/14
JP-2002140944	SUMITOMO ELECTRIC IND LTD	5/17/2002	SUPERCONDUCTIVE CABLE	H01B 012/14
JP-2002140943	SUMITOMO ELECTRIC IND LTD	5/17/2002	SUPERCONDUCTIVE CABLE	H01B 012/14
EP-1220239 A1	Pirelli Cavi E Sistemi S.P.A. (Italy)	7/3/2002	Superconducting cable	H01B 012/14
US-6417458	The Furukawa Electric Co., Ltd.	7/9/2002	Superconducting cable for alternating current	H01B 012/00

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B1	(Japan, Tokyo)			
US-6448501 B1		9/10/2002	Armored spring-core superconducting cable and method of construction	H01B 012/02
JP-2002260458	SUMITOMO ELECTRIC IND LTD	9/13/2002	METHOD FOR CONTROLLING VAPORIZING SPEED OF COOLANT OF SUPERCONDUCTING CABLE	H01B 012/16
JP-2002530829 A	エヌ・ケー・ティー リサーチ センター アクティーゼルスカブ	9/17/2002	Assembly method of superconducting multiphase cable	H01B 012/16
US-20020134574 A1		9/26/2002	Superconducting cable having a flexible former	H01B 012/00
JP-2002279834	Hitachi Cable Ltd	9/27/2002	OXIDE SUPERCONDUCTING WIRE AND ITS MANUFACTURING METHOD	H01B 012/10
JP-2002289049 A	NIPPON STEEL CORP	10/4/2002	Electric member used low resistance conductor and that manufacturing method and this	H01B 012/02
JP-2002289049	NIPPON STEEL CORP	10/4/2002	LOW-RESISTANCE CONDUCTOR AND ITS MANUFACTURING METHOD, AND ELECTRIC MEMBER USING THEM	H01B 012/02
JP-2002533895 A	ピレリー・カビ・エ・システミ・ソチエタ・ペル・アツィオーニ	10/8/2002	Superconducting cable	H01B 012/12
JP-2002533894 A	ピレリー・カビ・エ・システミ・ソチエタ・ペル・アツィオーニ	10/8/2002	Superconducting cable	H01B 012/12
US-20020148101 A1	Sumitomo Electric Industries, Ltd.	10/17/2002	Method of manufacturing superconducting cable	H01B 012/00
US-20020153162 A1		10/24/2002	Superconducting cable	H01B 012/00
EP-0830694 B1	Pirelli Cavi E Sistemi S.P.A. (Italy)	12/4/2002	A.C. CABLE WITH TWO CONCENTRIC CONDUCTOR CONFIGURATIONS OF STRANDED SINGLE CONDUCTORS	H01B 012/08
US-20030000731 A1		1/2/2003	Superconducting cable	H01B 012/00
JP-2003501779 A	アメリカン スーパーコンダクター コーポレイション	1/14/2003	減結合 of superconducting element in high temperature superconducting complex	H01B 012/10
US-20030010527 A1		1/16/2003	HIGH POWER SUPERCONDUCTING CABLE	H01B 012/00
US-6512311 B1	Pirelli Cavi S.p.A. (Italy, Milan)	1/28/2003	High power superconducting cable	H01B 012/16
US-6518504 B1	Brookhaven Science Associates, LLC (United States of America, Upton, NY)	2/11/2003	Power superconducting power transmission cable	H01B 012/60
US-20030029629 A1		2/13/2003	Methods for joining high temperature superconducting components in a superconducting cable with negligible critical current degradation and articles of manufacture in accordance therewith	H01B 012/00
US-6552260 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaki), Tokyo Electric Power Company (Japan)	4/22/2003	Superconducting cable and method of analyzing the same	H01B 012/02
WO-2003034447 A1	Southwire Company (United States)	4/24/2003	SUPERCONDUCTING CABLE TERMINATION	H01B 012/00
JP-2003141946	SUMITOMO ELECTRIC IND LTD	5/16/2003	SUPERCONDUCTING CABLE	H01B 012/02
US-6566609 B2	Sumitomo Electric Industries, Ltd. (Japan)	5/20/2003	Oxide superconducting wire	H01B 012/00
US-6576843 B1	Brookhaven Science Associates, LLC (United States of America, Upton, NY)	6/10/2003	Power superconducting power transmission cable	H01B 012/60
US-6596945 B1	Southwire Company (United States of America, Carrollton, GA)	7/22/2003	Superconducting cable	H01B 012/00
WO-0223557 A9	Southwire Company (United States)	7/31/2003	SUPERCONDUCTING CABLE	H01B 012/00
JP-2003526175 A	ピレリー・カビ・エ・システミ・ソチエタ・ペル・アツィオーニ	9/2/2003	High temperature superconducting cable and that manufacturing method	H01B 012/02
US-20030164246 A1	Pirelli Cavi E Sistemi S.P.A.	9/4/2003	Superconducting cable	H01B 012/00
JP-2003249130	SUMITOMO ELECTRIC IND LTD	9/5/2003	DIRECT-CURRENT SUPERCONDUCTIVE CABLE	H01B 012/08
EP-0786783 B1	Pirelli S.p.A. (Italy, Milano)	9/24/2003	Method for transmitting a predetermined current by a high power superconducting cable	H01B 012/16
US-6633003 B2	Pirelli Cavi E Sistemi S.P.A. (Italy, Milan)	10/14/2003	Superconducting cable and composite tubular element	H01B 012/00

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US-20030201119 A1		10/30/2003	Integrated tape	H01B 012/00
JP-2003331659	Fujikura Ltd	11/21/2003	SUPERCONDUCTING TRANSITION SEGMENT CONDUCTOR, AND ITS MANUFACTURING METHOD	H01B 012/08
DE-10221534 A1	Nexans, Paris, FR	11/27/2003	Line tube for transport of frozen mediums	H01B 012/16
US-20040000421 A1		1/1/2004	Low alternating current (ac) loss superconducting cable	H01B 012/00
JP-2004030967 A	Fujikura Ltd	1/29/2004	Superconducting rearranged segment conductor and that manufacturing method	H01B 012/08
US-20040020683 A1		2/5/2004	Superconducting power cable with enhanced superconducting core	H01B 012/00
US-20040026117 A1		2/12/2004	Superconducting cable	H01B 012/00
JP-2004063225 A	Fujikura Ltd	2/26/2004	DISLOCATION SUPERCONDUCTIVITY TAPE UNIT AND SUPERCONDUCTIVE CABLE	H01B 012/08
EP-1414049 A2	Nexans SuperConductors GmbH (Germany)	4/28/2004	Superconducting cable conductor with REBCO-coated conductor elements	H01B 012/06
US-6730851 B2	Pirelli Cavi E Sistemi S.P.A. (Italy, Milan)	5/4/2004	Superconducting cable and current transmission and/or distribution network including the superconducting cable	H01B 012/00
DE-10249550 A1	Nexans SuperConductors GmbH, 50354 Hürth, DE	5/6/2004	Superconducting cable conductor with SEBCO-laminated conductor elements	H01B 012/02
EP-1418596 A2	EMS-Europa Metalli Superconductors S.p.A. (Italy, 50127 Firenze)	5/12/2004	Cold composition method for obtaining a bar-like semifinished product from which to produce high-performance superconducting cables, particularly of niobium-titanium	H01B 012/02
US-6745059 B2	American Superconductor Corporation (United States, Westborough, MA)	6/1/2004	Superconductor cables and magnetic devices	H01B 012/00
US-6743984 B2	Pirelli Cavi E Sistemi S.P.A. (Italy, Milan)	6/1/2004	Electrical power transmission system using superconductors	H01B 012/00
JP-2004158448 A	Nexans SuperConductors GmbH	6/3/2004	SUPERCONDUCTING CABLE CONDUCTOR HAVING REBCO-COATED CONDUCTOR ELEMENT	H01B 012/06
JP-2004199940 A	Mitsubishi Electric Corp	7/15/2004	SUPERCONDUCTING CABLE DEVICE	H01B 012/16
EP-1441367 A2	Sumitomo Electric Industries, Ltd (Japan, Osaka-shi,, Osaka 541–0041)	7/28/2004	Superconducting cable	H01B 012/16
EP-1441366 A1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi,, Osaka 541–0041)	7/28/2004	SUPERCONDUCTING CABLE AND SUPERCONDUCTING CABLE LINE	H01B 012/02
JP-2004227939 A	SUMITOMO ELECTRIC IND LTD	8/12/2004	SUPERCONDUCTING CABLE	H01B 012/16
EP-1455367 A1	Sumitomo Electric Industries, Ltd. (Japan)	9/8/2004	DC SUPERCONDUCTING CABLE	H01B 012/08
US-6794579 B1	Pirelli Cavi E Sistemi S.P.A. (Italy, Milan)	9/21/2004	High temperature superconducting cable	H01B 012/00
EP-1467382 A2	Sumitomo Electric Industries, Ltd (Japan, Osaka-shi,, Osaka 541–0041)	10/13/2004	Superconducting cable	H01B 012/00
US-20040200637 A1	Sumitomo Electric Industries, Ltd. (United States)	10/14/2004	Superconducting cable	H01B 012/00
US-20040206544 A1		10/21/2004	Cold composition method for obtaining a bar-like semifinished product from which to produce high-performance superconducting cables, particularly of niobium-titanium	H01B 012/00
US-20040211586 A1		10/28/2004	Superconducting cable termination	H01B 012/00
US-20040216915 A1		11/4/2004	Dc superconducting cable	H01B 012/00
JP-2004349250 A	Nexans	12/9/2004	Manufacturing method of superconducting cable	H01B 012/16
EP-1489629 A2	Sumitomo Electric Industries, Ltd (Japan, Osaka-shi,, Osaka 541–0041)	12/22/2004	Superconducting cable and superconducting cable line using the same	H01B 012/02
US-20040256144 A1	Sumitomo Electric Industries, Ltd. (United States), The Tokyo Electric Power Company, Incorporated (United States)	12/23/2004	Phase split structure of multiphase superconducting cable	H01B 012/00

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US-20040256142 A1	Sumitomo Electric Industries, Ltd. (United States), The Tokyo Electric Power Company, Incorporated (United States)	12/23/2004	Phase split structure of multiphase superconducting cable	H01B 012/00
US-20040256141 A1	Sumitomo Electric Industries, Ltd. (United States)	12/23/2004	Superconducting cable and superconducting cable line using the same	H01B 012/00
US-20040256140 A1		12/23/2004	Super conducting cable conductor with REBCO-coated conductor elements	H01B 012/00
US-20040256126 A1	Sumitomo Electric Industries, Ltd. (United States), The Tokyo Electric Power Company, Incorporated (United States)	12/23/2004	Superconducting cable joint structure	H01B 012/00
US-6835892 B2	PIRELLI CAVI E SISTEMI S.P.A (Italy, Milan)	12/28/2004	Superconducting cable	H01B 012/00
US-6842634 B2	Metal Manufacturers Limited (Austria, North Rocks)	1/11/2005	Integrated tape	H01B 012/00
US-6844490 B2	Pirelli Cavi E Sistemi S.P.A. (Italy, Milan)	1/18/2005	Superconducting cable	H01B 012/00
US-20050011666 A1		1/20/2005	Superconducting cable having a flexible former	H01B 012/00
JP-2005019323 A	Fujikura Ltd, CHUBU ELECTRIC POWER CO INC	1/20/2005	TRANSPOSITION SEGMENT AND SUPERCONDUCTOR APPLYING EQUIPMENT	H01B 012/08
JP-2005032698 A	SUMITOMO ELECTRIC IND LTD	2/3/2005	SUPERCONDUCTING CABLE, AND SUPERCONDUCTING CABLE LINE USING THE SAME	H01B 012/02
US-6864430 B2	Southwire Company (United States, Carrollton, GA)	3/8/2005	Superconducting cable having a flexible former	H01B 012
WO-2005022562 A1	JAPAN SCIENCE AND TECHNOLOGY AGENCY (Japan), Central Research Institute of Electric Power Industry (Japan)	3/10/2005	SUPERCONDUCTING FILM AND METHOD OF MANUFACTURING THE SAME	H01B 012/06
US-6867375 B2	Southwire Company (United States, Carrollton, GA)	3/15/2005	Superconducting cable having a flexible former	H01B 012
JP-2005078939 A	CENTRAL RES INST OF ELECTRIC POWER IND, JAPAN SCIENCE & TECHNOLOGY AGENCY	3/24/2005	Superconducting film and that manufacturing method	H01B 012/06
US-20050061537 A1	Sumitomo Electric Industries, Ltd. (United States), The Tokyo Electric Power Company, Incorporated (United States)	3/24/2005	Terminal structure of superconducting cable and superconducting cable line therewith	H01B 012/00
JP-2005078939 A	CENTRAL RES INST OF ELECTRIC POWER IND, JAPAN SCIENCE & TECHNOLOGY AGENCY	3/24/2005	SUPERCONDUCTING FILM AND ITS MANUFACTURING METHOD	H01B 012/06
US-20050067184 A1	LG CABLE LTD., a corporation of Republic of Korea (Republic of Korea, Seoul)	3/31/2005	Jointing structure and jointing method for superconducting cable	H01B 012/00
JP-2005100777 A	SUMITOMO ELECTRIC IND LTD	4/14/2005	SUPERCONDUCTING CABLE	H01B 012/02
JP-2005510843 T	アメリカン スーパーコンダクター コーポレイション	4/21/2005	Superconductor cable and magnetic device	H01B 012/06
JP-2005510843 A	アメリカン スーパーコンダクター コーポレイション	4/21/2005	Superconductor cable and magnetic device	H01B 012/06
US-20050103519 A1	Brandsberg, Timothy A. (United States, Goode, VA), Batchelder, Robert R. (United States, Lynchburg, VA), Weber, Charles M. (United States, Forest, VA), Karasik, Vladimir (United States, Forest, VA)	5/19/2005	Low loss superconducting cable in conduit conductor	H01B 012/00
US-20050126805 A1	LG CABLE LTD. (United States)	6/16/2005	High-vacuum-maintaining structure of superconducting cable	H01B 012/00
JP-2005166577 A	SUMITOMO ELECTRIC IND LTD	6/23/2005	OXIDE SUPERCONDUCTING WIRE ROD, SUPERCONDUCTING EQUIPMENT, SUPERCONDUCTING CABLE, AND MANUFACTURING METHOD OF OXIDE SUPERCONDUCTING WIRE ROD	H01B 012/16
EP-1551038 A1	Servicios Condumex S.A. (Mexico, C.P.76120 Queretaro, Qro.)	7/6/2005	Superconducting power cable with enhanced superconducting core	H01B 012/00
US-20050155785 A1	Hauner, Franz (Federal Republic of Germany, Rottenbach), Robertson Ferrier, William Andrew (Great Britain, Worcestershire)	7/21/2005	Method of producing a sheath for a multifilament superconducting cable and sheath thus produced	H01B 012/00

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US-20050173149 A1	Gouge, Michael J. (United States, Oak Ridge, TN), Fisher, Paul W. (United States, Oak Ridge, TN), Foster, C.A. (United States, Oak Ridge, TN), Cole, M.J. (United States, Oak Ridge, TN), Lindsay, David (United States, Carrolton, GA)	8/11/2005	Triaxial superconducting cable and termination therefor	H01B 012/00
US-6936772 B2	Southwire Company (United States, Carrollton, GA)	8/30/2005	Superconducting cable having a flexible former	H01B 012/00
US-6936771 B2	Southwire Company (United States, Carrollton, GA)	8/30/2005	Superconducting cable termination	H01B 012/00
US-20050194178 A1	Xin, Ying (China, Beijing), Zhang, Yong (China, Beijing), Gong, Weizhi (China, Beijing)	9/8/2005	Hybrid superconducting cable for power transmission	H01B 012/00
JP-2005527939 A	メタラー テクノロジーズ インターナショナル エス．アー．	9/15/2005	Manufacturing method of coating for multifilament superconducting cable and produced coating	H01B 012/10
US-6946428 B2	Rey, Christopher M. (United States, Knoxville, TN)	9/20/2005	Magnesium -boride superconducting wires fabricated using thin high temperature fibers	H01B 012/00
US-6951985 B1	Lemelson, Jerome H. (United States, Incline Village, NV)	10/4/2005	Superconducting electrical cable	H01B 012/00
WO-2005096322 A1	Industrial Research Limited (New Zealand)	10/13/2005	COMPOSITE SUPERCONDUCTOR CABLE PRODUCED BY TRANSPOSING PLANAR SUBCONDUCTORS	H01B 012/02
US-6972376 B2	Southwire Company (United States, Carrollton, GA)	12/6/2005	Superconducting cable	H01B 012/00
US-6972374 B2	Servicios Condumex S.A. de C.V. (Mexico, Queretaro)	12/6/2005	Flexible conductor code for superconducting power cable and manufacturing process thereof	H01B 012/00
US-6985761 B2	Pirelli S.p.A. (Italy, Milan)	1/10/2006	Superconducting cable	H01B 012/00
US-7009104 B2	Pirelli Cavi E Sistemi S.P.A. (Italy, Milan)	3/7/2006	Superconducting cable	H01B 012/00
JP-2006114448 A	Hitachi Ltd, Hitachi Cable Ltd, KYUSHU ELECTRIC POWER CO INC	4/27/2006	CABLE-IN-CONDUIT TYPE SUPERCONDUCTOR	H01B 012/10
US-7038141 B2	Servicios Condumex S.A. de C.V. (Mexico, Queretaro)	5/2/2006	Superconducting power cable with enhanced superconducting core	H01B 012/00
WO-2006048985 A1	Sumitomo Electric Industries, Ltd. (Japan)	5/11/2006	SUPERCONDUCTING CABLE	H01B 012/16
JP-2006140122 A	SUMITOMO ELECTRIC IND LTD	6/1/2006	SUPERCONDUCTIVE CABLE	H01B 012/02
EP-1667172 A1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka 541–0041)	6/7/2006	SUPER-CONDUCTIVE CABLE OPERATION METHOD AND SUPER-CONDUCTIVE CABLE SYSTEM	H01B 012/16
EP-1667171 A1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka 541–0041)	6/7/2006	SUPER-CONDUCTIVE CABLE	H01B 012/02
JP-2006156328 A	SUMITOMO ELECTRIC IND LTD	6/15/2006	SUPERCONDUCTIVE CABLE	H01B 012/16
JP-2006156163 A	FURUKAWA ELECTRIC CO LTD:THE	6/15/2006	SUPERCONDUCTOR AND ITS MANUFACTURING METHOD	H01B 012/12
WO-2006075833 A1	LS CABLE LTD. (Republic of Korea)	7/20/2006	SUPERCONDUCTING POWER CABLE CAPABLE OF QUENCH DETECTION AND QUENCH DETECTION SYSTEM USING THE SAME	H01B 012/02
JP-2006210263 A	YYL:KK	8/10/2006	Superconducting electric transmission cable and electric transmission system	H01B 012/02
US-20060175078 A1	Sumitomo Electric Industries, Ltd. (United States)	8/10/2006	Super-conductive cable	H01B 012/00
US-7091423 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka)	8/15/2006	Superconducting cable	H01B 012/00
US-20060180328 A1	Sumitomo Electric Industries, Ltd. (United States)	8/17/2006	Super-conductive cable operation method and super-conductive cable system	H01B 012/00
US-7094973 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka), The Tokyo Electric Power Company, Incorporated (Japan, Tokyo)	8/22/2006	Superconducting cable joint structure	H01B 012/00
JP-2006228740 A	LS Cable LTD	8/31/2006	Low temperature maintenance device for superconducting cable, including the net layer provided with adsorbent	H01B 012/14
US-7102083 B2	LG CABLE LTD. (Republic of Korea, Seoul)	9/5/2006	Jointing structure and jointing method for superconducting cable	H01B 012/00
US-7109425 B2	SuperPower, Inc. (United States, Schenectady, NY)	9/19/2006	Low alternating current (AC) loss superconducting cable	H01B 012/00

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WO-2006098068 A1	Sumitomo Electric Industries, Ltd. (Japan)	9/21/2006	超電導ケーブル	H01B 012/08
WO-2006111170 A2	NKT Cables Ultera A/S (Denmark)	10/26/2006	A SUPERCONDUCTIVE MULTI-PHASE CABLE SYSTEM, A METHOD OF ITS MANUFACTURE AND ITS USE	H01B 012/16
JP-2006310310 A	Nexans	11/9/2006	Superconducting cable	H01B 012/04
JP-2006310310 A	Nexans	11/9/2006	SUPERCONDUCTING CABLE	H01B 012/04
US-20060254804 A1	Sumitomo Electric Industries, Ltd. (United States), The Tokyo Electric Power Company, Incorporated (United States)	11/16/2006	Superconducting cable joint structure	H01B 012/00
US-20060260837 A1		11/23/2006	Conduction cooling of a superconducting cable	H01B 012/00
JP-2006324255 A	AMERICAN SUPERCONDUCTOR CORP	11/30/2006	Superconductor cable and magnetic device	H01B 012/06
JP-2006324255 A	AMERICAN SUPERCONDUCTOR CORP	11/30/2006	SUPERCONDUCTOR CABLE AND MAGNETIC DEVICE	H01B 012/06
US-20060272847 A1		12/7/2006	Superconductor cable	H01B 012/00
US-7149560 B2	Sumitomo Electric Industries, Ldt. (Japan, Osaka)	12/12/2006	Superconducting cable and superconducting cable line	H01B 012/00
US-7148423 B2	Sumitomo Electric Industries, Ltd (Japan, Osaka), The Tokyo Electric Power Company Incorporated (Japan, Tokyo)	12/12/2006	Phase split structure of multiphase superconducting cable	H01B 012/00
US-7151225 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka)	12/19/2006	Superconducting cable and superconducting cable line using the same	H01B 012/00
US-20060283620 A1	American Superconductor Corporation (United States)	12/21/2006	Method and apparatus for cooling a superconducting cable	H01B 012/00
US-7166804 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka)	1/23/2007	Terminal structure of superconducting cable and superconducting cable line therewith	H01B 012/00
US-20070029104 A1		2/8/2007	Superconductor cable	H01B 012/00
JP-2007059136 A	FURUKAWA ELECTRIC CO LTD:THE	3/8/2007	COMPOUND SUPERCONDUCTING WIRE MATERIAL, COMPOUND SUPERCONDUCTING CABLE, AND MANUFACTURING METHOD OF THEM	H01B 012/08
JP-2007087755 A	SUMITOMO ELECTRIC IND LTD	4/5/2007	HEAT INSULATION STRUCTURE	H01B 012/14
DE-19719738 B4	The Furukawa Electric Co., Ltd., Tokio/Tokyo, JP, The Tokyo Electric Power Co., Inc., Tokio/Tokyo, JP	4/12/2007	AC oxide superconductor cable and method for the production of an AC oxide superconductor video tape wire and an AC oxide superconductor round wire	H01B 012/04
US-20070084623 A1	Kabushiki Kaisha Y.Y.L. (United States)	4/19/2007	Direct current superconducting power transmission cable and system	H01B 012/00
US-7231239 B2		6/12/2007	Super conducting cable conductor with rebco-coated conductor elements	H01B 012/00
US-7238887 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka)	7/3/2007	DC superconducting cable	H01B 012/00
US-20070169957 A1	Sumitomo Electric Industries, Ltd (United States)	7/26/2007	Splice structure of superconducting cable	H01B 012/00
WO-2007083873 A1	LS CABLE LTD. (Republic of Korea)	7/26/2007	SUPERCONDUCTING CABLE	H01B 012/02
EP-1818948 A1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka 541–0041)	8/15/2007	SUPER-CONDUCTING CABLE	H01B 012/14
EP-1818947 A2	Tratos Cavi S.p.A. (Italy, 52036 Pieve S. Stefano AR)	8/15/2007	Superconductor cable	H01B 012/06
US-7265297 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka), The Tokyo Electric Power Company, Incorporated (Japan, Tokyo)	9/4/2007	Multiphase superconducting cable connection structure and multiphase superconducting cable line	H01B 012/00
US-20070227760 A1	GESELLSCHAFT FUER SCHWERIONENFORSCHUNG MBH (Federal Republic of Germany, Darmstadt)	10/4/2007	Superconducting Cable and Method for the Production Thereof	H01B 012/00

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US-7279639 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka), The Tokyo Electric Power Company, Incorporated (Japan, Tokyo)	10/9/2007	Superconducting cable joint structure	H01B 012/00
US-20070235211 A1		10/11/2007	Method for laying a superconductor cable	H01B 012/04
JP-2007273452 A	SUMITOMO ELECTRIC IND LTD	10/18/2007	OXIDE SUPERCONDUCTIVE WIRE, SUPERCONDUCTIVE STRUCTURE, MANUFACTURING METHOD FOR OXIDE SUPERCONDUCTIVE WIRE, SUPERCONDUCTIVE CABLE, SUPERCONDUCTIVE MAGNET, AND PRODUCT INCLUDING SUPERCONDUCTIVE MAGNET	H01B 012/10
WO-2007116519 A1	Sumitomo Electric Industries, Ltd. (Japan)	10/18/2007	SUPERCONDUCTING CABLE	H01B 012/00
WO-2007119655 A1	Sumitomo Electric Industries, Ltd. (Japan)	10/25/2007	SUPERCONDUCTING CABLE CORE AND SUPERCONDUCTING CABLE	H01B 012/14
US-7288715 B2	LG CABLE LTD. (Republic of Korea, Seoul)	10/30/2007	High-vacuum-maintaining structure of superconducting cable	H01B 012/00
JP-2007536700 A	スーパーパワー インコーポレイテッド	12/13/2007	System, sending the current including the superconducting conductor magnetically isolated	H01B 012/00
JP-2007329126 A	Nexans	12/20/2007	System with superconducting cable	H01B 012/16
JP-2007329126 A	Nexans	12/20/2007	SYSTEM WITH SUPERCONDUCTING CABLE	H01B 012/16
GB-2440182 A	SIEMENS MAGNET TECHNOLOGY LTD (United Kingdom), OXFORD SUPERCONDUCTING TECHNOL (United States of America)	1/23/2008	Wire-in-channel superconductor	H01B 012/06
WO-2008011184 A2	American Superconductor Corporation (United States)	1/24/2008	HIGH-CURRENT, COMPACT FLEXIBLE CONDUCTORS CONTAINING HIGH TEMPERATURE SUPERCONDUCTING TAPES	H01B 012/06
US-7332671 B2	Nexans (France)	2/19/2008	Connection arrangement for superconductor cable shields	H01B 012/00
JP-2008041661 A	Nexans	2/21/2008	System with superconducting cable	H01B 012/16
JP-2008041661 A	Nexans	2/21/2008	超伝導ケーブルを有するシステム	H01B 012/16
JP-2008047519 A	FURUKAWA ELECTRIC CO LTD, INT SUPERCONDUCTIVITY TECH	2/28/2008	超電導導体及び超電導導体を備えた超電導ケーブル	H01B 012/06
US-20080054876 A1	LS CABLE LTD. (Republic of Korea, Seoul)	3/6/2008	Superconducting Power Cable Capable Of Quench Detection And Quench Detection System Using The Same	H01B 012/02
JP-2008053215 A	FURUKAWA ELECTRIC CO LTD, YOKOHAMA NAT UNIV, INT SUPERCONDUCTIVITY TECH	3/6/2008	SUPERCONDUCTING WIRE ROD, SUPERCONDUCTOR, AND SUPERCONDUCTIVE CABLE	H01B 012/06
WO-2008011184 A3	American Superconductor Corporation (United States), YUAN, Jie (United States), OTTO, Alexander (United States), MASON, Ralph, P. (United States), MAGUIRE, James, F. (United States)	4/10/2008	HIGH-CURRENT, COMPACT FLEXIBLE CONDUCTORS CONTAINING HIGH TEMPERATURE SUPERCONDUCTING TAPES	H01B 012/06
US-20080119362 A1		5/22/2008	Cryogenic Apparatus of Superconducting Equipment	H01B 012/02
US-20080121411 A1		5/29/2008	Superconductive Cable	H01B 012/00
WO-2008065781 A1	Sumitomo Electric Industries, Ltd. (Japan), FUJIKAMI, Jun (Japan), AYAI, Naoki (Japan), KATO, Takeshi (Japan), KOBAYASHI, Shin-ichi (Japan)	6/5/2008	酸化物超電導線材、超電導構造体、酸化物超電導線材の製造方法、超電導ケーブルおよび超電導マグネットならびに超電導マグネットを含む製品	H01B 012/10
US-20080164048 A1	HIROSE MASAYUKI	7/10/2008	Superconducting Cable	H01B 012/08
JP-2008527669 A	エルエス ケーブル リミテッド	7/24/2008	Quench detection system the quench detection used possible superconducting power cable and this	H01B 012/06
US-20080190646 A1	FOLTS DOUGLAS C, MAGUIRE JAMES, YUAN JIE, MALOZEMOFF ALEXIS P	8/14/2008	PARALLEL CONNECTED HTS FCL DEVICE	H01B 012/00
US-		9/4/2008	Composite Superconductor Cable Produced by	H01B 012/06

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20080210454 A1			Transposing Planar Subconductors	
WO-2007136421 A3	SuperPower, Inc. (United States)	10/2/2008	ANTI-EPITAXIAL FILM IN A SUPERCONDUCTING ARTICLE AND RELATED ARTICLES, DEVICES AND SYSTEMS	H01B 012/00
US-7439448 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka), The Tokyo Electric Power Company Incorporated (Japan, Chiyoda-ku, Tokyo)	10/21/2008	Phase split structure of multiphase superconducting cable	H01B 012/00
US-7453041 B2	American Superconductor Corporation (United States, Devens, MA)	11/18/2008	Method and apparatus for cooling a superconducting cable	H01B 012/00
JP-2008287897 A	FURUKAWA ELECTRIC CO LTD:THE	11/27/2008	SUPERCONDUCTIVE CABLE	H01B 012/02
JP-2008287896 A	FURUKAWA ELECTRIC CO LTD:THE	11/27/2008	SUPERCONDUCTIVE CABLE	H01B 012/02
WO-2008148390 A1	NKT Cables Ultera A/S (Denmark), WILLEN, Dag (Sweden), TRAEHOLT, Chresten (Denmark), NIELSEN, Carsten Thidemann (Denmark)	12/11/2008	A POWER CABLE COMPRISING HTS TAPE(S)	H01B 012/16
US-20080312089 A1		12/18/2008	Superconducting Cable	H01B 012/02
EP-2006861 A1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka 541–0041)	12/24/2008	SUPERCONDUCTING CABLE	H01B 012/14
JP-2009076401 A	SUMITOMO ELECTRIC IND LTD	4/9/2009	SUPERCONDUCTIVE CABLE	H01B 012/08
US-20090131261 A1		5/21/2009	Superconducting electrical cable	H01B 012/10
JP-2009522743 A	エルエス ケーブル リミテッド	6/11/2009	Superconducting cable	H01B 012/10
JP-2009522733 A	スーパーパワー インコーポレイテッド	6/11/2009	耐epitaxial film and relating goods, device and system in goods of ultra-conductivity	H01B 012/06
US-20090229848 A1		9/17/2009	Superconducting cable	H01B 012/16
US-20090247412 A1	American Superconductor Corporation (United States, Devens, MA)	10/1/2009	SUPERCONDUCTING CABLE ASSEMBLY AND METHOD OF ASSEMBLY	H01B 012/10
WO-2009120833 A1	YUAN, Jie (United States), American Superconductor Corporation (United States), KING, Christopher, G. (United States), MAGUIRE, James, F. (United States)	10/1/2009	SUPERCONDUCTING CABLE ASSEMBLY AND METHOD OF ASSEMBLY	H01B 012/02
US-7598458 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka)	10/6/2009	Super-conductive cable	H01B 012/00
US-20090258787 A1	Hills, Inc. (United States, West Melbourne, FL)	10/15/2009	Superconducting Wires and Cables and Methods for Producing Superconducting Wires and Cables	H01B 012/02
US-7605329 B2	Nexans (France, Paris)	10/20/2009	Terminal structure	H01B 012/00
WO-2009134567 A2	HILLS,INC. (United States), WILKIE, Arnold, E. (United States), SHULER, Benjamin (United States), HAGGARD, Jeffrey, S. (United States)	11/5/2009	SUPERCONDUCTING WIRES AND CABLES AND METHODS FOR PRODUCING SUPERCONDUCTING WIRES AND CABLES	H01B 012/02
US-7633014 B2	Nexans (France, Paris)	12/15/2009	Superconductor cable	H01B 012/00
EP-2144255 A1	European High Temperature Superconductors GmbH & Co. KG (Germany, 63450 Hanau)	1/13/2010	Superconducting cable	H01B 012/06
US-20100071927 A1		3/25/2010	ELECTRICAL CONNECTION STRUCTURE FOR A SUPERCONDUCTOR ELEMENT	H01B 012/00
WO-2010039513 A1	YUAN, Jie (United States), American Superconductor Corporation (United States), MAGUIRE, James (United States)	4/8/2010	ELECTRICITY TRANSMISSION COOLING SYSTEM	H01B 012/16
WO-2010042259 A1	Massachusetts Institute of Technology (United States), TAKAYASU, Makoto (United States), MINERVINI, Joseph, V. (United States), BROMBERG, Leslie (United States)	4/15/2010	SUPERCONDUCTOR CABLE	H01B 012/00
US-20100099572	LS CABLE LTD. (Republic of Korea, Gyeonggi-do)	4/22/2010	SUPERCONDUCTING POWER CABLE CAPABLE OF QUENCH DETECTION AND QUENCH	H01B 012/04

Publication Number	Assignee	Publication Date	Title	Main IPC Class
A1			DETECTION SYSTEM USING THE SAME	
US-20100099571 A1	Bruker HTS GmbH (Germany, Hanau)	4/22/2010	Superconducting cable	H01B 012/02
US-20100099570 A1	TAKAYASU MAKOTO, MINERVINI JOSEPH V, BROMBERG LESLIE	4/22/2010	SUPERCONDUCTOR CABLE	H01B 012/10
US-7709742 B2	Nexans (France, Paris)	5/4/2010	Superconductor cable	H01B 012/00
JP-2010519679 A	アメリカン スーパーコンダクター コーポレーション	6/3/2010	Fault current restriction HTS cable and that structure method	H01B 012/16
US-7735212 B1	NKT Cables Ultera A/S (Denmark, Broendby)	6/15/2010	Superconducting multiphase cable comprising N phases and method of constructing the cable	H01B 012/16
EP-1552536 B1	Southwire Company (United States, Carrollton Georgia 30119)	6/23/2010	Termination for a triaxial superconducting cable	H01B 012/06
US-7743485 B1	Sumitomo Electric Industries, Ltd. (Japan, Osaka)	6/29/2010	Method of manufacturing a superconducting cable	H01B 012/02
US-7748102 B2	The Regents of the University of California (United States, Oakland, CA)	7/6/2010	Method for fabricating a conduction-cooled high-temperature superconducting cable	H01B 012/16
US-20100179064 A1	NKT Cables Ultera A/S (Denmark, Asnaes)	7/15/2010	POWER CABLE COMPRISING HTS TAPE(S)	H01B 012/16
US-20100184604 A1	NKT Cables Ultera A/S (Denmark, Asnaes)	7/22/2010	SUPERCONDUCTING ELEMENT JOINT, A PROCESS FOR PROVIDING A SUPERCONDUCTING ELEMENT JOINT AND A SUPERCONDUCTING CABLE SYSTEM	H01B 012/02
US-20100248969 A1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi)	9/30/2010	OXIDE SUPERCONDUCTING WIRE, SUPERCONDUCTING STRUCTURE, METHOD OF PRODUCING OXIDE SUPERCONDUCTING WIRE, SUPERCONDUCTING CABLE, SUPERCONDUCTING MAGNET, AND PRODUCT INCORPORATING SUPERCONDUCTING MAGNET	H01B 012/08
JP-2010287504 A	戸田工業株式会社	12/24/2010	Silver coated superconducting particle powder and superconducting cable	H01B 012/02
EP-2144255 B1	Bruker HTS GmbH (Germany, 63450 Hanau)	1/5/2011	Superconducting cable	H01B 012/06
JP-2011003468 A	SUMITOMO ELECTRIC IND LTD, International Superconductivity Technology Center	1/6/2011	SUPERCONDUCTIVE CABLE	H01B 012/02
JP-2011028936 A	TOKYO ELECTRIC POWER CO INC:THE, SUMITOMO ELECTRIC IND LTD	2/10/2011	HEAT INSULATING TUBE	H01B 012/14
EP-1467382 B1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka 541–0041)	2/16/2011	Superconducting cable	H01B 012/00
US-7895730 B2	FLORIDA STATE UNIVERSITY RESEARCH FOUNDATION (United States, Tallahassee, FL)	3/1/2011	Method of controlling effective impedance in a superconducting cable	H01B 012/02
JP-2011044437 A	Sumitomo Electric Industries	3/3/2011	Superconducting cable	H01B 012/02
US-7902461 B2	American Superconductor Corporation (United States, Westborough, MA)	3/8/2011	Fault current limiting HTS cable and method of configuring same	H01B 012/00
JP-2011076924 A	Sumitomo Electric Industries, INT SUPERCONDUCTIVITY TECH	4/14/2011	Superconducting cable	H01B 012/02
WO-2011043376 A1	Kyushu Institute of Technology (Japan), MATSUSHITA Teruo (Japan)	4/14/2011	超伝導ケーブル、及び交流送電ケーブル	H01B 012/02
DE-202006020944 U1	NKT Cables Ultera A/S, Asnaes, DK	4/21/2011	Superconducting multiphase cable system	H01B 012/16
JP-2011091057 A	SUMITOMO ELECTRIC IND LTD	5/6/2011	SUPERCONDUCTIVE CABLE FOR DIRECT CURRENT	H01B 012/02
US-7953466 B2	LS Cable LTD (Republic of Korea, Seoul)	5/31/2011	Superconducting cable	H01B 012/00
US-20110152105 A1		6/23/2011	SUPERCONDUCTING CABLE	H01B 012/10
US-7983727 B2	Fujitsu Limited (Japan, Kawasaki)	7/19/2011	Superconductor filter unit	H01B 012/02
US-7985925 B2	GSI HELMHOLTZZENTRUM FUER SCHWERIONENFORSCHUNG GMBH (Germany, Darmstadt)	7/26/2011	Superconducting cable and method for the production thereof	H01B 012/00
US-	Sumitomo Electric Industries, Ltd.	8/25/2011	SUPERCONDUCTING CABLE	H01B 012/16

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20110203827 A1				
EP-1717821 B1	Nexans (France, 75008 Paris)	9/28/2011	Superconducting cable	H01B 012/06
US-8039742 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka)	10/18/2011	Superconductive cable	H01B 012/00
WO-2011133025 A1	DeMaCo Holland bv (Netherlands), WULFFERS, Christiaan Arnoldus (Netherlands)	10/27/2011	DEVICE FOR TRANSPORTING CURRENT THROUGH A SUPERCONDUCTING POWER CABLE	H01B 012/16
EP-1492200 B1	The Tokyo Electric Power Company Incorporated (Japan, Tokyo 100–0011), Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka 541–0041)	11/2/2011	Phase split structure of multiphase superconducting cable	H01B 012/02
WO-2011145616 A1	Sumitomo Electric Industries, Ltd. (Japan), NATIONAL INSTITUTE FOR MATERIALS SCIENCE (Japan), AYAI, Naoki (Japan), UGLIETTI, Davide (Japan), KIYOSHI, Tsukasa (Japan)	11/24/2011	酸化物超電導線材およびその使用方法、超電導コイルおよびその製造方法、ソレノイドマグネット	H01B 012/02
WO-2011159176 A1	General Cable Superconductors Limited (New Zealand), STAINES, Michael (New Zealand), JIANG, Zhenan (New Zealand)	12/22/2011	IMPROVED TRANSPOSED SUPERCONDUCTING CABLE	H01B 012/08
FR-2963474 A1	Nexans (France)	2/3/2012	ELEMENT OF TRANSPORT OF ENERGY, ESPECIALLY CABLE EQUIPPED WITH A DEVICE OF ELECTRICAL ENERGY STORAGE	H01B 012/00
EP-2426677 A1	Nexans (France, 75008 Paris)	3/7/2012	Superconducting cable	H01B 012/16
EP-2447957 A2	General Electric Company (United States, Schenectady, NY 12345)	5/2/2012	Superconducting cable system	H01B 012/06
US-20120103659 A1	General Electric Company (United States, Schenectady, NY)	5/3/2012	SUPERCONDUCTING CABLE SYSTEM	H01B 012/02
EP-1667171 B1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka 541–0041)	6/13/2012	SUPER-CONDUCTIVE CABLE	H01B 012/02
EP-2487691 A1	Kyushu Institute of Technology (Japan, Kitakyushu-shi, Fukuoka 804–8550)	8/15/2012	SUPERCONDUCTOR CABLE AND AC POWER TRANSMISSION CABLE	H01B 012/02
US-20120214676 A1	MATSUSHITA TERUO	8/23/2012	SUPERCONDUCTOR CABLE AND AC POWER TRANSMISSION CABLE	H01B 012/02
US-20120214675 A1	THE REGENTS OF THE UNIVERSITY OF COLORADO, A BODY CORPORATE	8/23/2012	SUPERCONDUCTING CABLES AND METHODS OF MAKING THE SAME	H01B 012/02
US-20120214672 A1	LS CABLE LTD. (Republic of Korea, Anyang-si)	8/23/2012	ARRANGEMENT METHOD OF SUPERCONDUCTING WIRES OF A SUPERCONDUCTING CABLE	H01B 012/16
US-8253024 B2	Siemens plc (United Kingdom, Frimley, Camberley)	8/28/2012	Method and apparatus for cooling superconductive joints	H01B 012/00
WO-2012124810 A1	Furukawa Electric Co., Ltd. (Japan), MUKOYAMA, Shinichi (Japan), YAGI, Masashi (Japan), YONEMURA, Shuka (Japan), MATSUOKA, Taro (Japan), TENG, Jun (Japan)	9/20/2012	超電導ケーブルの固定構造及び超電導ケーブル線路の固定構造	H01B 012/16
US-8280467 B2	American Superconductor Corporation (United States, Devens, MA)	10/2/2012	Electricity transmission cooling system	H01B 012/16
US-20120252677 A1		10/4/2012	SUPERCONDUCTIVE CABLE	H01B 012/02
US-20120295792 A1		11/22/2012	ARRANGEMENT FOR ELECTRICALLY CONDUCTIVELY CONNECTING TWO ELECTRICAL UNITS	H01B 012/16
US-8332005 B2	Nexans (France, Paris)	12/11/2012	Superconducting electrical cable	H01B 012/02
JP-2012256508 A	SUMITOMO ELECTRIC IND LTD, International Superconductivity Technology Center	12/27/2012	SUPERCONDUCTIVE WIRE ROD AND SUPERCONDUCTIVE CABLE	H01B 012/06
EP-1836711 B1	LS CABLE LTD. (Republic of Korea, Gyeonggi-do)	1/2/2013	SUPERCONDUCTING POWER CABLE CAPABLE OF QUENCH DETECTION AND QUENCH DETECTION SYSTEM USING THE SAME	H01B 012/02
JP-2013004196 A	CHUGOKU ELECTRIC POWER CO INC:THE	1/7/2013	DRIFT CURRENT SUPPRESSION METHOD AND SUPERCONDUCTIVE CABLE	H01B 012/02
US-8354591 B2	Sumitomo Electric Industries, Ltd. (Japan, Osaka)	1/15/2013	Superconducting cable	H01B 012/00

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JP-2013016482 A	ネクサン	1/24/2013	Superconductor cable	H01B 012/14
JP-2013016482 A	Nexans	1/24/2013	Superconductor cable	H01B 012/14
US-8369912 B2	Bruker HTS GmbH (Germany, Hanau)	2/5/2013	Superconducting cable	H01B 012/02
US-20130065766 A1	American Superconductor Corporation (United States, Devens, MA)	3/14/2013	ELECTRICITY TRANSMISSION COOLING SYSTEM	H01B 012/16
WO-2012112923 A3	THE REGENTS OF THE UNIVERSITY OF COLORADO, A BODY CORPORATE (United States), VAN DER LAAN, Daniel, Cornelias (United States)	3/14/2013	SUPERCONDUCTING CABLES AND METHODS OF MAKING THE SAME	H01B 012/06
EP-1441366 B1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka 541–0041)	4/3/2013	SUPERCONDUCTING CABLE AND SUPERCONDUCTING CABLE LINE	H01B 012/02
US-8437819 B2	Massachusetts Institute of Technology (United States, Cambridge, MA)	5/7/2013	Superconductor cable	H01B 012/02
US-8442605 B2	NKT Cables Ultera A/S (Denmark, Asnaes)	5/14/2013	Power cable comprising HTS tape(s)	H01B 012/00
JP-2013105639 A	Fujikura Ltd	5/30/2013	Superconducting cable	H01B 012/02
EP-2602796 A1	Furukawa Electric Co., Ltd. (Japan, Chiyoda-ku Tokyo 100–8322)	6/12/2013	SUPERCONDUCTOR CABLE ANCHORING STRUCTURE AND SUPERCONDUCTOR CABLE LINE ANCHORING STRUCTURE	H01B 012/16
US-20130150246 A1	NKT Cables Ultera A/S (Denmark, Asnaes)	6/13/2013	SUPERCONDUCTIVE MULTI-PHASE CABLE SYSTEM, A METHOD OF ITS MANUFACTURE AND ITS USE	H01B 012/14
WO-2013089219 A1	Mayekawa Mfg. Co., Ltd. (Japan), Railway Technical Research Institute (Japan)	6/20/2013	超電導ケーブル、並びに超電導ケーブルの冷却装置及び冷却方法	H01B 012/16
JP-2013125647 A	株式会社前川製作所, 公益財団法人鉄道総合技術研究所	6/24/2013	Cooling system of superconducting cable and superconducting cable and cooling method	H01B 012/16
JP-2013125647 A	MAYEKAWA MFG CO LTD, Railway Technical Research Institute	6/24/2013	SUPERCONDUCTING CABLE, AND DEVICE AND METHOD FOR COOLING THE SAME	H01B 012/16
US-20130165326 A1	International Superconductivity Technology Center (Japan, Tokyo), Furukawa Electric Co., Ltd. (Japan, Tokyo)	6/27/2013	SUPERCONDUCTING CABLE LINE	H01B 012/02
US-20130165324 A1	Jang, Hyun Man (Republic of Korea, Hwaseong-si), Lee, Su Kil (Republic of Korea, Gumi-si), Kim, Young Woong (Republic of Korea, Suwon-si), Ryu, Cheol Hwi (Republic of Korea, Ansan-si)	6/27/2013	SUPERCONDUCTING CABLE	H01B 012/06
US-8478374 B2	American Superconductor Corporation (United States, Devens, MA)	7/2/2013	Superconducting cable assembly and method of assembly	H01B 012/00
EP-2615614 A1	CHUBU UNIVERSITY EDUCATIONAL FOUNDATION (Japan, Kasugai-shi, Aichi 487–8501)	7/17/2013	SUPERCONDUCTING POWER TRANSMISSION SYSTEM	H01B 012/14
JP-2013140691 A	SUMITOMO ELECTRIC IND LTD	7/18/2013	STRUCTURE OF INTERCONNECTING SUPERCONDUCTING CABLE, AND METHOD OF CONNECTING SUPERCONDUCTING CABLE	H01B 012/02
US-20130196857 A1	International Superconductivity Technology Center (Japan, Tokyo), Furukawa Electric Co., Ltd. (Japan, Tokyo)	8/1/2013	SUPERCONDUCTING CABLE	H01B 012/02
US-20130199821 A1	Furukawa Electric Co., Ltd. (Japan, Chiyoda-ku)	8/8/2013	FIXATION STRUCTURE OF SUPERCONDUCTING CABLE AND FIXATION STRUCTURE OF SUPERCONDUCTING CABLE LINE	H01B 012/02
EP-1966837 B1	SuperPower, Inc. (United States, Schenectady, NY 12304)	8/21/2013	ANTI-EPITAXIAL FILM IN A SUPERCONDUCTING ARTICLE AND RELATED ARTICLES, DEVICES AND SYSTEMS	H01B 012/00
US-20130240236 A1	CHUBU UNIVERSITY EDUCATIONAL FOUNDATION (Japan, Kasugai-shi, Aichi)	9/19/2013	SUPERCONDUCTING POWER TRANSMISSION SYSTEM	H01B 012/00
US-20130244881 A1	NKT Cables Ultera A/S (Denmark, Asnaes)	9/19/2013	SUPERCONDUCTING ELEMENT JOINT, A PROCESS FOR PROVIDING A SUPERCONDUCTING ELEMENT JOINT AND A SUPERCONDUCTING CABLE SYSTEM	H01B 012/16
WO-2013151100 A1	CHUBU UNIVERSITY EDUCATIONAL FOUNDATION (Japan)	10/10/2013	超伝導ケーブルと設置方法	H01B 012/16
DE-	"Federal Grid Company of	10/17/2013	Superconducting cable	H01B 012/02

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202013005989 U1	Unified Energy System" Joint Stock Company (Russian Federation, Moskau), "Research and Development Center at Federal Grid Company of Unified Energy System" Joint Stock Company (Russian Federation, Moskau)			
US-20130333912 A1	Mayekawa Mfg. Co., Ltd. (Japan, Tokyo)	12/19/2013	SUPERCONDUCTING CABLE COOLING SYSTEM	H01B 012/16
WO-2014011254 A2	American Superconductor Corporation (United States)	1/16/2014	REDUCED-LOSS BUCKING BUNDLE LOW VOLTAGE CABLE	H01B 012/02
US-20140027141 A1	International Superconductivity Technology Center (Japan, Tokyo), Furukawa Electric Co., Ltd. (Japan, Tokyo)	1/30/2014	TERMINAL CONNECTING PART OF SUPERCONDUCTING CABLE	H01B 012/16
US-20140051582 A1	Nexans (France, Paris)	2/20/2014	ARRANGEMENT WITH AT LEAST ONE SUPERCONDUCTIVE CABLE	H01B 012/16
WO-2014011254 A9	American Superconductor Corporation (United States)	3/6/2014	REDUCED-LOSS BUCKING BUNDLE LOW VOLTAGE CABLE	H01B 012/02
WO-2014003606 A3	"FEDERAL GRID COMPANY OF UNIFIED ENERGY SYSTEM", JOINT-STOCK COMPANY (Russian Federation), "RESEARCH, AND DEVELOPMENT CENTER AT FEDERAL GRID COMPANY OF UNIFIED ENERGY SYSTEM" JOINT-STOCK COMPANY (Russian Federation), ZHELTOV, Vladimir Valentinovich (Russian Federation), KOPYLOV, Sergej Igorevich (Russian Federation), KRIVECKIJ, Igor' Vladimirovich (Russian Federation), SYTNIKOV, Viktor Evgen'evich (Russian Federation), SHAKARJAN, Jurij Gevondovich (Russian Federation)	3/6/2014	СВЕРХПРОВОДЯЩИЙ КАБЕЛЬ (ВАРИАНТЫ)	H01B 012/12
EP-2071589 B1	Nexans (France, 75008 Paris)	5/14/2014	Superconducting electric cable	H01B 012/02
US-8748747 B2	Nexans (France, Paris)	6/10/2014	Arrangement with at least one superconductive cable	H01B 012/00
US-20140162883 A1	Nexans (France, Paris)	6/12/2014	ARRANGEMENT WITH AT LEAST ONE SUPERCONDUCTIVE CABLE	H01B 012/16
US-20140162882 A1	The Florida State University Research Foundation, Inc. (United States, Tallahassee, FL)	6/12/2014	CABLE TERMINATION FOR HIGH VOLTAGE POWER CABLES COOLED BY A GASEOUS CRYOGEN	H01B 012/16
US-20140221213 A1	Sumitomo Electric Industries, Ltd. (Japan, Osaka-shi, Osaka)	8/7/2014	SUPERCONDUCTING CABLE, SUPERCONDUCTING CABLE LINE, METHOD OF INSTALLING SUPERCONDUCTING CABLE, AND METHOD OF OPERATING SUPERCONDUCTING CABLE LINE	H01B 012/16
US-20140296077 A1	Fermi Research Alliance, LLC.	10/2/2014	METHOD AND SYSTEM FOR CONTROLLING CHEMICAL REACTIONS BETWEEN SUPERCONDUCTORS AND METALS IN SUPERCONDUCTING CABLES	H01B 012/10
US-20140302997 A1	Takayasu, Makoto (United States, Lexington, MA)	10/9/2014	Superconducting Power Cable	H01B 012/04
EP-2790190 A1	Sumitomo Electric Industries, Ltd. (Japan, Chuo-Ku Osaka-shi Osaka 541–0041)	10/15/2014	SUPERCONDUCTING CABLE, SUPERCONDUCTING CABLE LINE, METHOD OF INSTALLING SUPERCONDUCTING CABLE, METHOD OF OPERATING SUPERCONDUCTING CABLE LINE	H01B 012/08
EP-2793240 A1	Mayekawa Mfg. Co., Ltd. (Japan, Koto-ku Tokyo 135–8482), Railway Technical Research Institute (Japan, Kokubunji-shi, Tokyo 185–8540)	10/22/2014	SUPERCONDUCTING CABLE, AND DEVICE AND METHOD FOR COOLING SUPERCONDUCTING CABLE	H01B 012/16
US-8886267 B2	American Superconductor Corporation (United States, Devens, MA)	11/11/2014	Fault current limiting HTS cable and method of configuring same	H01B 012/02
US-8897845	Nexans (France, Paris)	11/25/2014	Arrangement for electrically conductively connecting	H01B 012/16

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B2			two electrical units	
WO-2014204560 A2	TAKAYASU, Makoto (United States)	12/24/2014	SUPERCONDUCTING POWER CABLE	H01B 012/04
US-20140378312 A1	Railway Technical Research Institute (Japan, Tokyo)	12/25/2014	SUPERCONDUCTING CABLE, AND DEVICE AND METHOD FOR COOLING SUPERCONDUCTING CABLE	H01B 012/16
US-20150018221 A1	Advanced Conductor Technologies LLC (United States, Boulder, CO)	1/15/2015	MULTIPHASE COAXIAL SUPERCONDUCTING CABLES AND CORC DEGAUSSING SYSTEM	H01B 012/06
US-20150014019 A1	UIDUK University Industry-Academic Cooperation Foundation (Republic of Korea, Gyeongju-si)	1/15/2015	3-COAXIAL SUPERCONDUCTING POWER CABLE AND CABLE'S STRUCTURE	H01B 012/02
EP-2599091 B1	Nexans (France, 75008 Paris)	1/21/2015	POWER TRANSMISSION ELEMENT, IN PARTICULAR A CABLE, PROVIDED WITH A DEVICE FOR STORING ELECTRICAL POWER	H01B 012/02
EP-2827344 A1	Tratos Cavi S.p.A. (Italy, 52036 Pieve S. Stefano AR)	1/21/2015	Superconductor electric cable and method for the obtainment thereof	H01B 012/06
US-20150031546 A1	Furukawa Electric Co., Ltd. (Japan, Tokyo), International Superconductivity Technology Center (Japan, Kawasaki-shi, Kanagawa)	1/29/2015	CONNECTION STRUCTURE FOR SUPERCONDUCTING CABLES	H01B 012/02
JP-2015032525 A	FURUKAWA ELECTRIC CO LTD:THE	2/16/2015	CONNECTION STRUCTURE OF SUPERCONDUCTIVE CABLES, SUPERCONDUCTIVE CABLE, AND CURRENT TERMINAL STRUCTURE OF TERMINAL EDGE OF SUPERCONDUCTIVE CABLE	H01B 012/02
US-20150080225 A1	Furukawa Electric Co., Ltd. (Japan, Chiyoda-ku, Tokyo)	3/19/2015	INTERMEDIATE CONNECTION UNIT OF SUPERCONDUCTING CABLES	H01B 012/16
US-9006576 B2	Nexans (France, Paris)	4/14/2015	System with a superconductive cable and a surrounding cryostat	H01B 012/00
US-9006146 B2	International Superconductivity Technology Center (Japan, Tokyo), Furukawa Electric Co., Ltd. (Japan, Tokyo)	4/14/2015	Superconducting cable	H01B 012/00
US-9012780 B2	UIDUK University—Academic Coorportion Foundation (Republic of Korea, Gyeongju-si)	4/21/2015	3-coaxial superconducting power cable and cable's structure	H01B 012/02
US-20150107867 A1	Furukawa Electric Co., Ltd. (Japan, Tokyo), International Superconductivity Technology Center (Japan, Kanagawa)	4/23/2015	STRUCTURE AND METHOD FOR CONNECTING FORMERS OF SUPERCONDUCTING CABLES	H01B 012/16
US-20150111756 A1	THE REGENTS OF THE UNIVERSITY OF COLORADO, A BODY CORPORATE (United States, Denver, CO)	4/23/2015	SUPERCONDUCTING CABLES AND METHODS OF MAKING THE SAME	H01B 012/08
JP-2015153590 A	古河電気工業株式会社	8/24/2015	End part structure of superconducting cable and superconducting cable	H01B 012/16
US-9123459 B2	Nexans (France, Paris)	9/1/2015	Arrangement with at least one superconductive cable	H01B 012/16
WO-2015139081 A1	BELOGIANNIS, Alexander (Australia)	9/24/2015	A SUPERCONDUCTING CABLE	H01B 012/00
US-20150325338 A1	American Superconductor Corporation (United States, Devens, MA)	11/12/2015	ELECTRICITY TRANSMISSION COOLING SYSTEM	H01B 012/16
EP-2827344 B1	Tratos Cavi S.p.A. (Italy, 52036 Pieve S. Stefano AR)	11/18/2015	Superconductor electric cable and method for the obtainment thereof	H01B 012/06

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